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THE SURGERY OF THE INNOMINATE ARTERY, WITH SPECIAL REFERENCE TO ANEURYSM*

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I AM honoured by this invitation to deliver the second William Sheen Memorial Lecture within his native city. Four and a half years have rolled away since this great surgeon passed from our midst, a martyr to his high sense of duty and imbued with a spirit that to the end scorned submission to the arctic menace of winter or to adverse Fate. Reared and nurtured in a doctor's home in Cardiff, he not unnaturally received his early education within the semicircle of hills around the city, and being the eldest of eleven children may have acquired in early life his seemingly natural gift to lead and to command. He studied at Guy's Hospital in days when the distinguished names on the surgical staff of that great Institution were those of Henry Howse, Durham, whose house surgeon Sheen became, J. N. Davies-Colley, Clement Lucas, 'Pom' Jacobson, Charters Symonds, and Arbuthnot Lane.

FIG. 503.—Alfred Sheen, Surgeon to the Cardiff Infirmary, 1871–90.

FIG. 504.—Alfred William Sheen, C.B.E., T.D., F.R.C.S.

Some of William Sheen's surgical courage may have been inherited from his father, Alfred Sheen (*Fig.* 503), a practitioner-surgeon on the staff of the Cardiff Infirmary, who in two patients during this very week of this selfsame month sixty-eight years ago successfully ligatured the external iliac for aneurysm of the common femoral artery, only three days intervening between these two surgical incursions; the second patient celebrated his recovery by 'signing the pledge'.

* The William Sheen Memorial Lecture delivered in Cardiff on November 4, 1949.

William Sheen may also have owed his administrative qualities to his father, for the latter was honoured by a presentation made to him for outstanding ability and skill in organizing a highly successful meeting of the British Medical Association in Cardiff in 1885. Perhaps the son lacked the father's zeal for pen and paper, since the latter was in very truth a polemic writer and indefatigable controversialist.

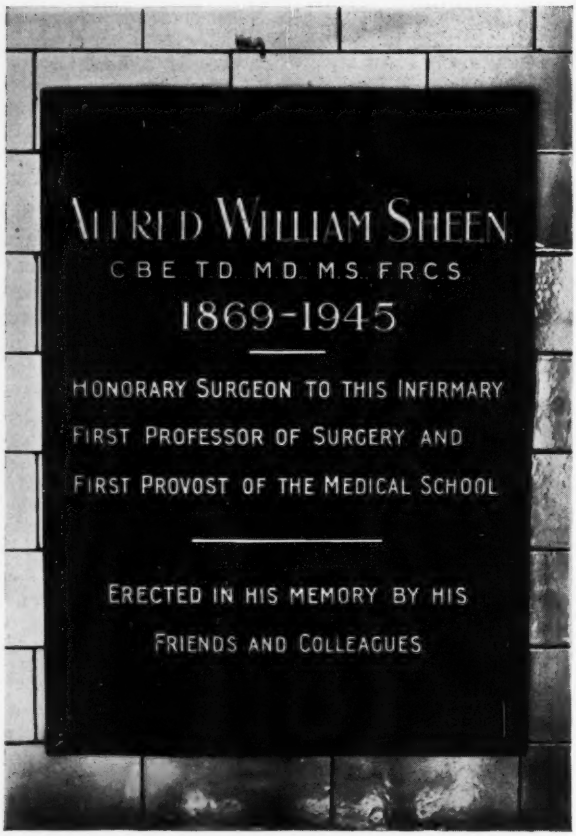
ALFRED WILLIAM SHEEN
C B E T D M D M S F R C S
1869-1945
HONORARY SURGEON TO THIS INFIRMARY
FIRST PROFESSOR OF SURGERY AND
FIRST PROVOST OF THE MEDICAL SCHOOL
ERECTED IN HIS MEMORY BY HIS
FRIENDS AND COLLEAGUES

FIG. 505.—Plaque erected to the memory of Alfred William Sheen within the Royal Infirmary, Cardiff.

Apart from his burning desire to render service to mankind in all its ills, William Sheen was ardent in his duty to his sovereign and his country, and saw service in the Boer War and in the First Great War of 1914–18.

Fifty-one years have passed since ' The Colonel ' joined the surgical staff of the Cardiff Royal Infirmary (1898), and in the respective roles of keen Territorial Officer, Surgeon to a great Hospital (*Fig.* 504), first Provost of a new National Welsh Medical School (*Fig.* 505), and Deputy Lieutenant for Glamorgan, William Sheen may truly be acclaimed as one who faithfully served his country, his county, his city, and his school.

My selection of a subject for tonight's address has been influenced by a somewhat capricious personal experience of aneurysm of the innominate artery, or of aneurysm where ligature of the innominate has seemed the appropriate method of treatment; but my choice may not be considered inopportune, since Cardiff and the great surgeon whom we commemorate to-night are intimately associated with the surgery of this artery, for in 1904 William Sheen successfully ligatured the innominate, thereby making himself the eighth surgeon in the world to achieve success in this enterprise, the third in Great Britain and Ireland, the second on this side of the Irish Sea, and the first in the Principality. A patriotic reason has also suggested this choice of subject to me; more than a dozen years have elapsed since the last paper dealing with the surgical treatment of innominate aneurysm came from the pen of a British writer, and in the interval that has elapsed since Frank Rundle's excellent contribution to the BRITISH JOURNAL OF SURGERY (1937), several communications have emanated from the surgeons of the United States. The real purpose of this address is, therefore, to put on record a number of cases of ligature of the innominate artery that have not been published heretofore, and also to arrange and bring up to date, as far as possible, the cases where ligature of this artery has been demanded in the treatment of aneurysm, or for primary or secondary hæmorrhage. Parenthetically, it may be added that the artery seems to have been ligatured more frequently by the surgeons of the British Empire than by those of any other nation in the world.

FIG. 506—Aortic arch: aneurysm ruptured into trachea. The arch of the aorta with the trachea. There is a fusiform enlargement of the arch, the inner surface of which shows irregular nodular thickening. Springing from the upper wall of the arch there is a saccular aneurysm, 1½ in. in diameter, which is directed upwards and forwards between the innominate and left carotid arteries. Behind this there is a second aneurysm which involves the origin of the innominate artery. The sac has two subsidiary dilatations, one projecting to the right, the other directed backwards so as to compress the trachea, into which it has ruptured through a transverse rent nearly an inch long. (*R.C.S. Museum, C.* 31 *a.* 9. *Donor: Frederick H. Ward,* 1886.)

Innominate aneurysm is not a frequent malady: thus only 5 cases were admitted into the wards of Middlesex Hospital in the fifty years from 1897 to 1947 inclusive, although a sixth has subsequently come under observation (1948). From information kindly gleaned for me by Mr. J. Marshall Pullan,

of St. Thomas's Hospital, there are records from this famous institution, whose story is so closely linked with the surgery of aneurysm by the work of Makins, Ballance, and Maybury, of 219 aneurysms of all types and sizes in the space of a quarter of a century, of which 10 were innominate aneurysms.

Even pathological specimens displaying innominate aneurysm are not very abundant in museums,

FIG. 507.—Aortic arch: fusiform aneurysm. The arch of the aorta showing a fusiform aneurysm which begins about 2 in. above the aortic valve and extends as far as the origin of the left subclavian artery. The dilatation at its widest part is 3 in. in diameter. (*R.C.S. Museum, C.* 31 *a.* 1. *Donor: J. Bland-Sutton,* 1888.)

although several are to be found on the shelves in Lincoln's Inn Fields (*Figs.* 506–508). One or two are depicted here from the museum of Middlesex Hospital (*Figs.* 509–513). Brock has figured elsewhere an illustration of one from the Gordon Museum at Guy's Hospital, and there are three or four examples in the Museum of St. Bartholomew's Hospital. Professor Matthew Stewart informs me that one exists in the Leeds Museum, placed there in 1859 by T. P. Teale, the father of the late Pridgin Teale; there is at least one in the Museum of the Fouad I University in Cairo, and *Fig.* 514 illustrates another in the Pathological Museum at Melbourne. They do not abound "as thick as autumnal leaves that strow the brooks in Vallombrosa".

The viewpoint of the surgeon of this decade in respect of the innominate artery differs from that of his grandfather, and surgical interest in problems relating to this blood-vessel has veered from that which obtained during the hundred years that succeeded Valentine Mott's pioneer attack on the innominate. These are the halcyon days of the surgical conquest of the thorax, of courageous and dexterous operations and of beautiful and exquisite technique, and during the past few years the innominate artery has come to be more specially considered in relationship to the performance of Blalock's operation of creating an artificial ductus arteriosus in the treatment of the tetralogy of Fallot. Although the innominate artery itself is only on the very rarest occasion utilized in the actual anastomosis, it is important as a signpost to the essential blood conduits, and must itself be thoroughly freed from the trammels of surrounding tissues to secure the maximum mobility for the subclavian artery to be anastomosed to the pulmonary. Radiography can now illumine the mediastinal compartments with a certainty that enables the surgeon to plan his incision according as the aortic arch is to the left or right, but whatever the disposition of the aorta the innominate remains the first branch to be given off.

FIG. 508.—Specimen showing the successful result from proximal ligature of the innominate for aneurysm of distal portion of the artery with two strands of kangaroo tendon. Death 3 years after. (*R.C.S Museum, C.* 31 *a.* 2.)

It would seem that to-day the luckless freaks of sportive Nature rather than the worshippers of Venus or the myrmidons of Mars furnish greater opportunity for bringing the surgeon and the innominate artery closely together.

Mott in 1818 had more vision than some of those who were in their hey-day in the latter half of last century. Although his own gallant effort had been unsuccessful, he wrote with prophetic foresight: "If the primitive iliac, when tied, will heal and we by this operation save the patient's life, why may we not with perfect propriety yet hope that someone is destined, in the brilliant march of surgical triumph, to obtain the like happy result from a ligature on the innominate?" However, the dismal results which followed the operation with ever-recurring, nearly inevitable, certainty almost justified the gloomy words of Gross who, while admiring the intrepid skill of Mott which could execute so daring and brilliant a feat, added that "obstacles meet the surgeon in every direction, even if he should be so fortunate as to get his ligature round the artery, which is not always the case". Erichsen gave it as his opinion that the operation should without doubt be banished from surgical practice! Velpeau, with slightly more caution, wrote: "At the present day I do not hesitate formally to proscribe it." Heath does not even mention the operation in his *Operative Surgery*. Such were the pronouncements of great surgeons of

the nineteenth century, but the oracle of to-day is wont to fall from its tripod on the morrow. Difficulties are placed before workers to rouse, not to discourage: the perilous adventures essayed by a former surgical generation are the commonplace commitments of their successors of the mid-twentieth century. How few remember that Billroth was stoned in the streets of Vienna because of the

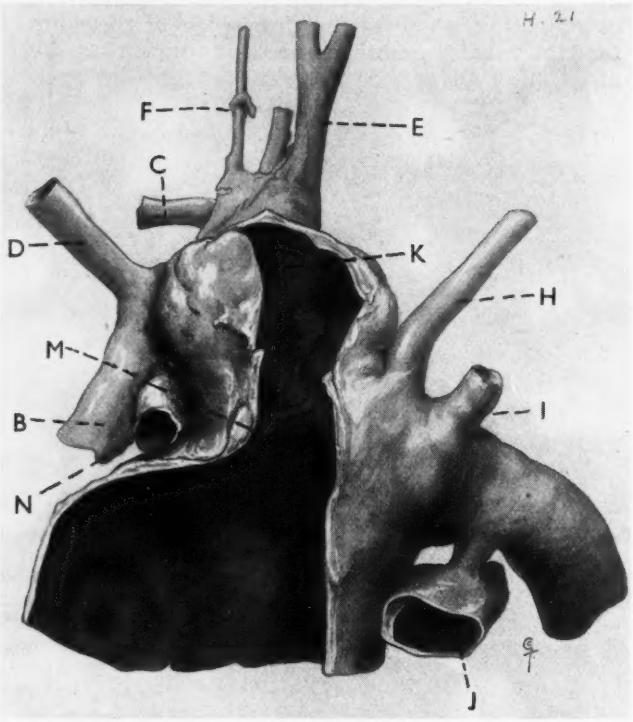

FIG. 509.—Saccular aneurysm 2 in. in diameter, situated at the origin of the innominate artery and involving adjacent parts of the aorta (anterior aspect). The innominate artery passed upwards behind the sac. The proximal 1½ in. of common carotid was completely obliterated. An attempt had been made to ligature innominate, but found impracticable. Patient survived exploration 14 days. B, Superior vena cava; C, Right subclavian artery; D, Right subclavian vein; E, Right common carotid artery; F, Interior jugular vein; H, Left common carotid; I, Left subclavian artery; J, Pulmonary artery; K, Right wall of innominate artery forming part of wall of aneurysm; M, Small aneurysmal pouch on posterior and left side of innominate; N, Left innominate vein thrown over to right side. (*Med.-chir. Soc. Trans.*, 1883, **66**, 93.) (*Middlesex Hospital Museum H.*21.)

inevitable mortality that was the aftermath of gastrectomy in its earliest period, whereas to-day the operation is performed with less risk than is run by the pedestrian who takes his life in his hand to cross the streets and roads of our towns and country! Irish surgeons have never been lacking in courage or the spirit of enterprise—Eire has contributed no fewer than ten of the cases in which the innominate has been ligatured, the majority with success—and although William Thomson,* of the Richmond Surgical Hospital, Dublin, in 1882 could only console himself with the reflection that the post-operative survival period of his patient (42 days) was at that time second only to Graefe's man, who lived 67 days, at least he had abundant confidence that success was certain in the near future.

The perfection of anæsthesia, penicillin, streptomycin, the sulpha drugs controlling infection, improved technique, and modern methods of resuscitation have so influenced results that those regions of the human body which defied or refused subjugation under the surgeon's knife are now territory into which even the novice may penetrate with certainty and safety.

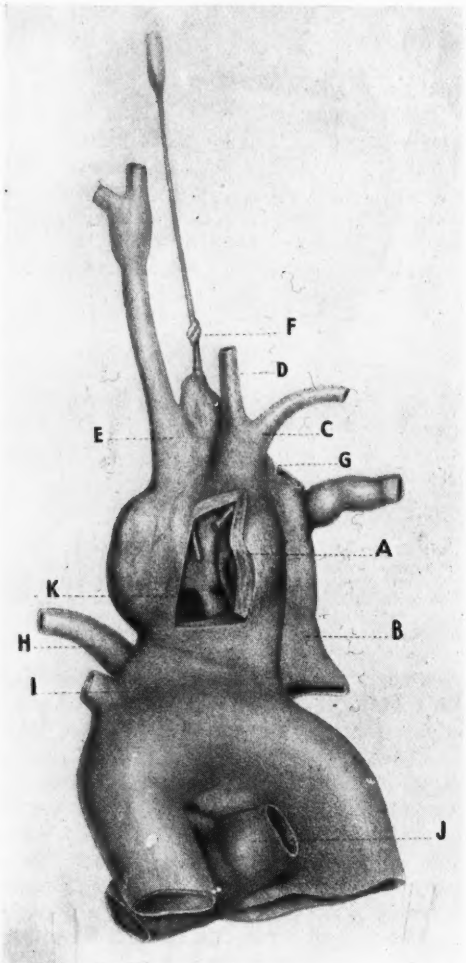

FIG. 510.—Same specimen (posterior aspect). A, Innominate artery laid open behind and exposing the two pouch-like dilatations in its wall, and the rods passing into the carotid and subclavian arteries; B, Superior vena cava; C, Subclavian artery; D, Right vertebral artery; E, Dilated origin of right common carotid; F, Knot of ligature on interior jugular vein; G, Interior jugular laid open just below where it leaves the wall of the aneurysm, and where it joins the right subclavian vein; H, Left carotid; I, Left subclavian artery; J, Right pulmonary artery; K, Opening from innominate into sac of aneurysm.

A survey of the literature shows that it is the general surgeon rather than the thoracic specialist who figures most abundantly in the lists of those called upon to ligature the innominate, although the thoracic surgeons in the ordinary routine of chest interventions have "established quite friendly relationships with this vessel" (Price Thomas), and Holmes Sellors has himself operated for innominate

* Thomson's operation was performed in the presence or with the assistance of Mr. Thornley Stoker, Mr. Stokes, Mr. Corley, and Professor Bennett (of 'Bennett's fracture').

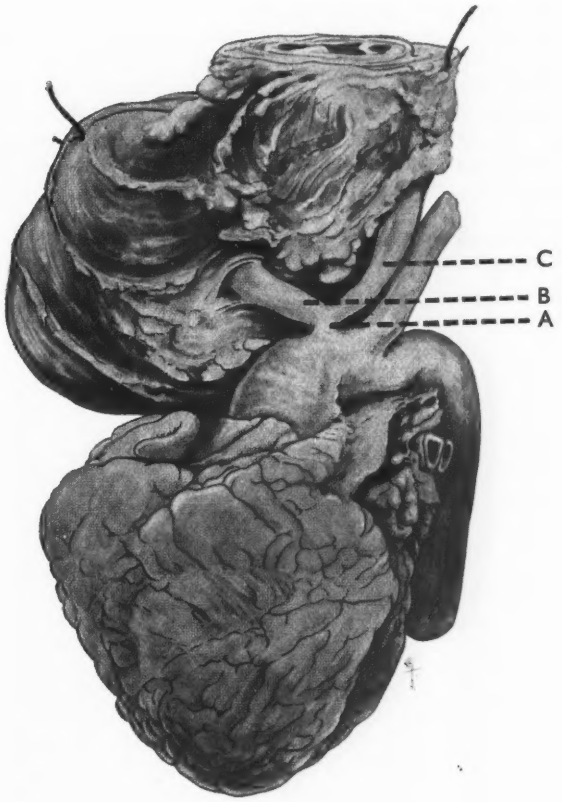

FIG. 512.—Innominate artery leads into an aneurysm 3½ in. in diameter on right side, and the more recent, 2 in. in diameter, can be seen rising from the superior surface of the main swelling, showing a dumb-bell-like constriction corresponding to the region of the thoracic inlet. *Note* laminated appearance of the old organized clot, and the more recent clot below. *The innominate and left common carotid arteries arose from the aorta by a common trunk.* (Anterior aspect.) A, Common origin of innominate and left carotid—innominate carotid trunk appears small, since it had been ligatured (ligature removed); B, Innominate artery; C, Left common carotid. (*Middlesex Hospital Museum, H.*18.1.)

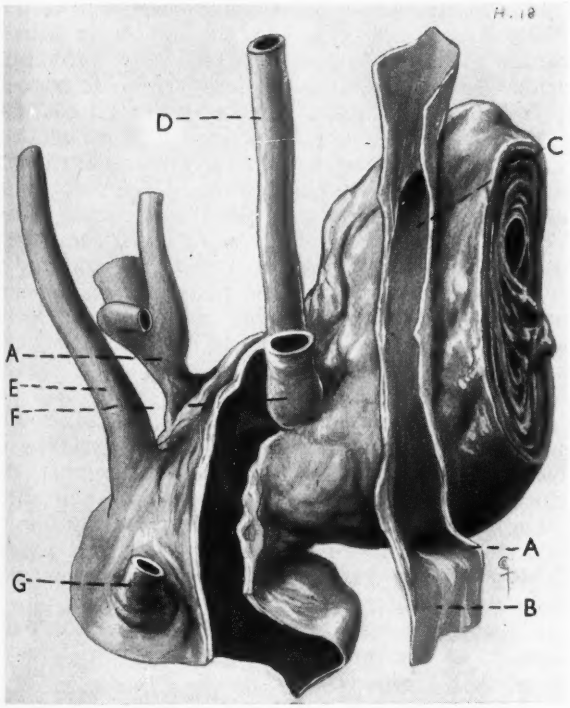

FIG. 511.—Springing from the posterior wall of the innominate artery at its origin there is a saccular aneurysm 5 in. in diameter, which projects upwards and to the right. Sac filled with laminated clot and completely compresses left innominate vein, which, with the terminal part of the left subclavian vein, contains adherent thrombus. A, Left innominate vein compressed by aneurysm and containing clot; B, Superior vena cava; C, Right innominate vein; D, Right common carotid; E, Left common carotid; F, Right subclavian artery; G, Left subclavian artery. (*Middlesex Hospital Museum, H.*18.)

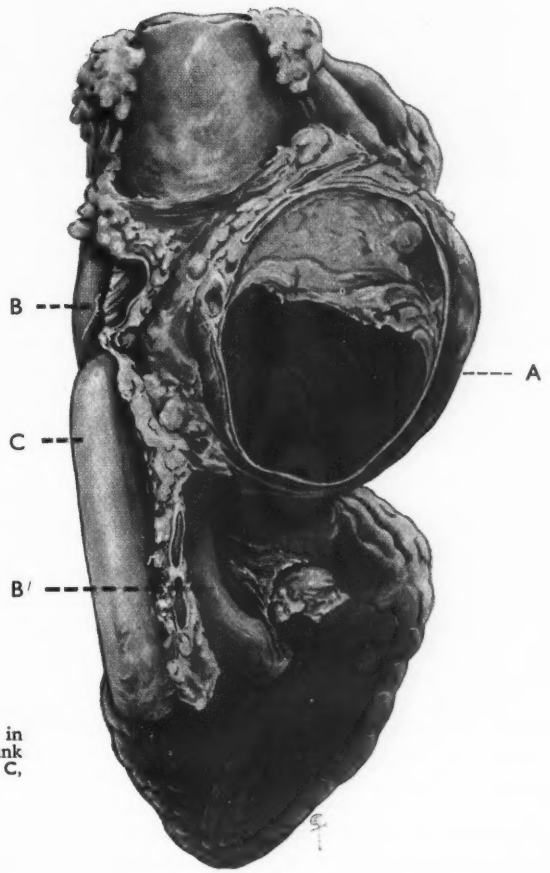

FIG. 513.—Aneurysm of innominate artery shown in *Fig.* 512 looked at from right side, an innomino-carotid trunk existed. A, Recent clot in aneurysm; B, B', Œsophagus; C, Descending aorta. (*Middlesex Hospital Museum, H.*18.1.)

aneurysm on four occasions. A temporary ligature or a temporary clamp on the innominate has of course often been employed in the performance of Blalock's operation and in dealing with aneurysms or arteriovenous fistulæ at the root of the neck.

According to Sheen, the innominate artery had been successfully ligated seven times before his own case in 1904: but critical analysis of the cases

FIG. 514.—Aneurysm of innominate artery originating at its proximal portion and demonstrating impossibility of proximal ligature. (*Royal Melbourne Hospital Museum.*)

mentioned in his paper would substitute the name of Alberto Hernandez of Mexico (1896) for that of Mitchell Banks (1883) of Liverpool, who is mentioned by Sheen as one of his successful predecessors. Although Mitchell Banks's patient, who had an aneurysm of the third part of the subclavian, made an immediate recovery from ligature of the innominate and carotid arteries, *pulsation returned in the aneurysm the following day*, and sixty-seven days after the first operation the first part of the subclavian had to be tied, the aneurysm then becoming small, hard, and free from pulsation. The patient, however, succumbed from repeated hæmorrhages thirty-seven days after the second operation or 104 days after the innominate artery had been tied: *the innominate artery was found after death to be still patent.*

Abraham Colles (1773–1843), the distinguished Dublin surgeon, has been credited by some with the distinction of having been the first to ligature the innominate artery successfully, but of the truth of this statement there is very grave doubt. His claim to priority in this surgical field was mentioned in a former number of the BRITISH JOURNAL OF SURGERY, the author evidently quoting from G. T. Bettany's notice in the *Dictionary of National Biography* (1887). Moreover, Garrison is sceptical of the statement, and had Colles merited the credit the late Sir William Wheeler (*Fig.* 534) would certainly have paid tribute to him, whereas with patriotic pride he records such names as Coppinger, O'Grady, Thomson, Porter, etc., all of Dublin (*Figs.* 529, 527, 528, 524, 525), in connexion with early attempts to ligate the innominate artery (*see Figs.* 524–532). My own inquiries fail to substantiate the claims of his biographer; Colles certainly ligated the very commencement of the right subclavian in 1811, when the operation had only been twice attempted in Europe. The controversy therefore merely ranges around a refinement of anatomical nomenclature.

Priority in respect of successful ligature of the innominate on the part of surgeons on the Eastern shores of the Atlantic indubitably belongs to Charles Philip Coppinger (*Fig.* 529) of the Mater Misericordiæ Hospital, Dublin (1893). With pardonable pride Coppinger showed his successful case not only in Ireland but at surgical meetings on the English side of the Irish Sea, paying the man's fares, hotel bills, etc. There is a sad sequel to this early tour of triumph, since many years later the patient developed corneal ulceration and even went blind of an eye. When Coppinger had tired of financing him, the patient used to sit on the surgeon's doorstep and say to every patient coming to the house for an appointment: "Look what he has done to me!" He worried Coppinger enormously and helped to ruin his practice, till eventually the surgeon is said to have become a drug addict.

The surgeons who had been able to achieve success before Sheen were A. W. Smyth (1864) of New Orleans, Burrell (1895) of Philadelphia, and Curtis (1900) of New York in 1899; Coppinger (1893) of Dublin, and Charters Symonds of Guy's; Hernandez (1900) of Mexico in 1896, and Lewtas (1889)* of the Indian Medical Service, operating in the Punjab.

The year 1904 also witnessed another successful ligature of the innominate artery by the Japanese surgeon, K. Saigo (1906).

Ligature of Innominate Artery by A. W. Sheen.—Sheen's patient was a labourer, 46 years of age, who, although he had served in the Army abroad, furnished no history pointing to venereal disease. On Feb. 2, 1904, he was admitted to the Cardiff Royal Infirmary for an *aneurysm of the second and third parts of the right subclavian artery.* His earliest symptoms, which had commenced six months before admission, were numbness and tingling in the right hand; the swelling above the right clavicle had only been noticed by the patient six days before his arrival in hospital and was conveniently hailed by himself as an industrial sequel to the jar of the hammer with which he had been working during that day!

The man spent two months in hospital prior to operation, which was delayed by reason of the scabies, eczema, and numerous 'boils' about the body and limbs, for which treatment was required.

* Lieut.-Col. John Lewtas (1851–1920), C.B.E., I.M.S. saw service in the Afghanistan Campaign of 1878–80, etc.

On March 31, the innominate and right common carotid were tied under chloroform anæsthesia (*Fig.* 515). Of those who took part in the operation all but one are dead—Professor William Sheen; Mr. William Martin, Assistant Surgeon to the Infirmary; Dr. F. W. S. Davies, the anæsthetist; Dr. T. W. Thomas, of Caerphilly, the patient's own doctor. The two other residents in the Infirmary at that time have also 'passed on'—Dr. Samuel and Dr. A. B. Timms,* the famous Scottish Rugby centre three-quarter in the earliest years of the century. Dr. Alexander Brownlee alone survives and is living in retirement; he was second assistant at the operation and, after attaining the Fellowship of the Royal College of Surgeons of Edinburgh in 1905, became Superintendent of the Tuberculosis Hospital at Glan Ely (Cardiff) and did a certain amount of surgery himself.

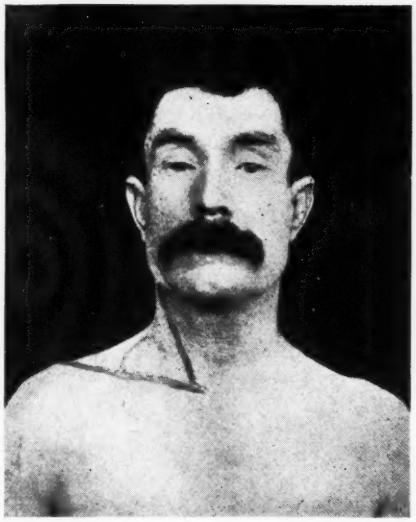

FIG. 515.—Sheen's patient before operation. The outline of the aneurysm, the upper border of the clavicle, and the inner margin of the sternomastoid have been marked in indian ink. (*From* '*Annals of Surgery*', 1905.)

Sheen had apparently intended to ligate the first part of the subclavian, but in the effort to clear and identify this structure a slight hissing sound occurred, probably due to an injury to the pleura. This ceased on packing in a gauze plug, but recurred when the gauze was removed. The gauze was therefore left in place, and the dissection carried downwards on to the innominate, and by means of Macewen's right-angle hernia needle a ligature of stout floss silk (Down Brothers, London, No. 2 'pearl' silk) was carried round the artery from the lateral to the medial side. The silk was passed double round the vessel and the two ligatures thus provided were tied in Ballance's 'stay knot'. The intention was to occlude the artery without injuring the coats; a fair amount of force was required before pulsation in the aneurysm ceased. The carotid was tied in a 'surgical knot' with Chinese twist. The pulsation returned to some extent in the aneurysm the day following this first operation.

During May the patient had epigastric pain and other dyspeptic symptoms, but these were to a large extent explained when on one occasion, as recorded by Sheen and re-affirmed quite recently by Brownlee, the patient was found dead drunk in the hospital garden, and consternation was all the greater by the absence of the radial pulse (right) when a nurse was first summoned to him. On May 19 an unsuccessful attempt was made to ligate the innominate artery again, the operation having to be abandoned because of alarming venous bleeding when the aneurysm needle was being coaxed around the artery. Finally on June 2, 1904, the second part of the subclavian was tied close up to the aneurysm. Recovery took place with consolidation of the aneurysm.

When the patient was seen *eight and a half months after the first operation* the sac was a flattish, slightly tender area of the diameter of half a crown; there was no pulsation in it. A very feeble pulse could be felt in the right radial and temporal arteries; no pulse could be felt in the right carotid or brachial arteries; the nutrition and general appearances of the right arm were as good as those of the left. The man, however, still complained of pain in the right arm and shoulder, of difficulty in lifting the right arm, and of some tingling down the extremity. There is a note to the effect that the man was probably making the most of his symptoms, for he had not done a stroke of work since the operations and was continuing to draw compensation for his so-called 'accident'. He removed to Portsmouth and information as to his subsequent health is not forthcoming.

My own clinical interest in the innominate artery commenced within a few months of leaving the dissecting room for the hospital wards nearly half a century ago.

Case 1.—Joseph F., aged 38, was admitted to Middlesex Hospital under the care of Sir James Kingston Fowler during October, 1901, for an aneurysm of the innominate artery, and the writer, as a clinical clerk, was responsible for the notes of the case and for carrying out the treatment enjoined.

The man had a pulsating swelling coming from behind the right sternoclavicular joint and obtruding itself under the sternomastoid and in the supraclavicular region. He was short of breath on exertion; his right arm was completely paralysed, and there were disturbances of sensation below the level of the right elbow-joint. Horner's sign was present on the right side; the right radial pulse could not be felt.

Sir Henry Morris was invited to see the case with a view to ligaturing the innominate artery, but declined to operate. The patient was therefore placed upon Lancereaux'* treatment consisting of intramuscular injections of gelatin with a view to increasing the coagulability of the blood and promoting clotting in the

* A. B. Timms was a famous Scottish centre three-quarter in teams which included such famous names in the back division as A. N. Fell, A. Phipps-Turnbull, W. M. Welsh, J. I. Gillespie, E. Simson, and F. H. Fasson. These were days when the Principality was represented by men like R. Meredith Owen of Swansea with 35 caps, W. J. Trew of Swansea with 30, E. Gwynne Nicholls of Cardiff with two dozen, R. T. Gabe with two dozen, "Teddy" Morgan with 16, and other legendary names in the proud story of Welsh rugby football.

* Etienne Lancereaux (1829–1910), pupil of Claude Bernard, Physician to La Pitié, Paris.

aneurysmal sac. These injections were prepared in the Bacteriological Department of Middlesex Hospital under the supervision of the late Dr. A. G. R. Foulerton, and were continued at bi-weekly intervals for several months. Estimations of the clotting-time of the patient's blood were made daily by W. T. Hillier, of the Pathological Department, and a marked shortening of the clotting-time of the blood was always observed the day following the gelatin injection, increasing slowly till the next injection. A progressive diminution in the tension and expansile pulsation was observed, until on his discharge from hospital in August, 1902, pulsation could scarcely be felt. There was diminution in the extent and degree of the paralysis, but considerable anæsthesia still remained. Nevertheless this man earned his livelihood as a commissionaire up to the time of outbreak of the First Great War in 1914 opening the doors of carriages, cabs, and motor vehicles outside a busy store, near the hospital of which he had been an in-patient. He has now been lost sight of, but his period of survival after treatment for his innominate aneurysm amounted to at least *thirteen years*.

Case 2.—**Saccular aneurysm of innominate artery: Proximal ligature. Death seven days later** (Gordon-Taylor).

R. C., male, aged 43 (*Fig.* 516). Operation, April 19, 1927. Syphilis in Africa in 1915: imperfect treatment. In a dynamite explosion in Africa in 1922, when he lost an eye and fractured his left jaw. Pulsating tumour under origin of right sternomastoid.

FIG. 516.—*Case* 2.—The pulsating tumour shown projecting above right sternoclavicular articulation.

OPERATION, 1927 (Gordon-Taylor, R. Vaughan Hudson, T. Holmes Sellors).—Both clavicles sectioned, and first and second ribs divided on each side. Sternum sawn across just below manubrio-gladiolar junction, and bony flap turned up. Innominate aneurysm situated near bifurcation, some leaking of blood and clot from sac while being exposed. Innominate artery ligatured by means of a stay knot of thick silk: some apprehension felt as each silk strand was tightened around the artery. Flap replaced. Operation took two-and-a-half hours.

On the seventh day alarming hæmorrhage occurred, and despite transfusion, etc., death ensued.

POST-MORTEM.—Despite the terrifying tightening of the ligature around the artery, there was still a patent lumen admitting a quill. The aneurysm was saccular and arose from the anterior aspect of the innominate at its bifurcation and the anterior wall of the sac had ruptured along most of its vertical length. The sac contained a large quantity of recent clot. Another aneurysm was present in connexion with the descending aorta, eroding the fifth and sixth dorsal vertebræ.

Case 3.—**Spontaneous aneurysm of innominate artery: Proximal ligature; immediate recovery. Death six weeks after from intercurrent malady** (Gordon-Taylor).

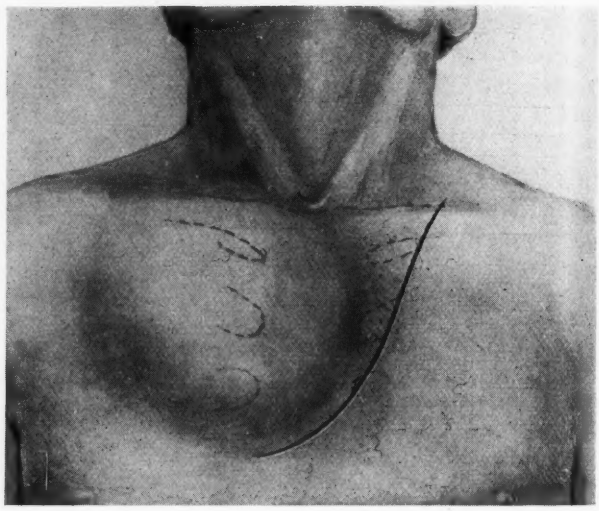

FIG. 517.—*Case* 3. Aneurysm can be seen bulging through sternum and upper right costal cartilages and presenting under skin. The incision for raising an osteofascial flap is shown.

K. C., male, aged 44 years, admitted to Middlesex Hospital under the care of Dr. E. A. Cockayne, August, 1936, with an aneurysm regarded as of innominate origin which had eroded the manubrium sterni and the right upper costal cartilages and was presenting under the skin (*Fig.* 517). Surgical opinion was sought and with the assistance of my friend and colleague, Mr. Eric Riches, I decided to attempt to get a ligature around the innominate artery. The pulsating tumour involving the anterior wall of the thorax and only separated by the integument from the outside world presented a somewhat fearsome appearance. An approach to the innominate artery by raising an osteofascial flap upwards and towards the right seemed to hold out most promise (*Fig.* 518), and the left clavicle and the three upper left costal cartilages were sectioned and the gladiolus carefully divided across opposite the third intercostal space with a Liebsche chisel. The bone-flap was carefully drawn upwards and to the right, taking with it the wall of the aneurysmal sac, which fortunately was connected with the distal half of the innominate artery; the commencement of the artery was exposed and cleared, the left innominate vein retracted upwards, and with a little difficulty an aneurysm needle was coaxed around the artery. A piece of tape was ultimately drawn under the artery, divided, and a Ballance 'stay knot' was tied. The osteofascial flap was replaced and the wound closed.

The man did well; all pulsation in the aneurysm ceased and did not recur. In view of a streptococcal

faucial infection which was attacking the hospital ward the patient was nursed in a side-room and was only returned to the ward when the epidemic seemed to have come to an end. Unfortunately, the transfer had been made prematurely, for the patient, whose surgical condition was eminently satisfactory, contracted the epidemic angina and developed a septicæmia.

This operation preceded the advent of sulphonamide therapy, and despite antistreptococcus serum, etc., the

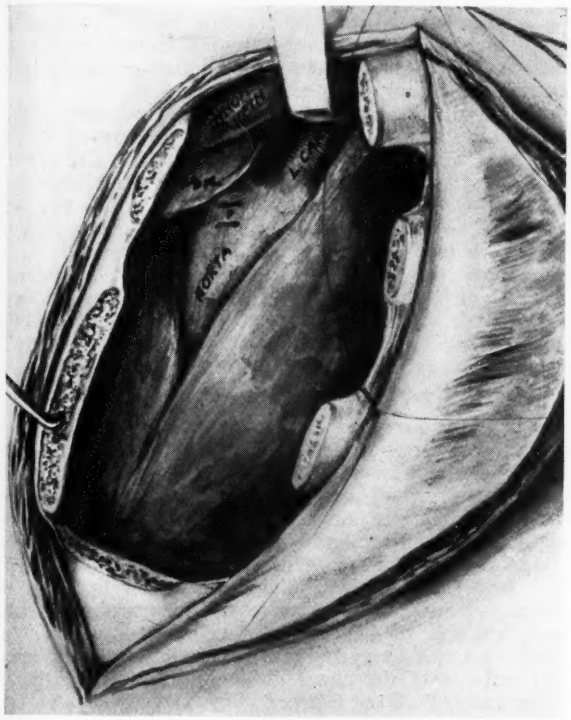

FIG. 518.—*Case* 3. Osteofascial flap turned up and to the right. I, Innominate artery; An, Aneurysm of innominate artery.

man died in hospital from this intercurrent malady when everything pointed to a successful result from surgery.

Case 4.—**Spontaneous aneurysm of the innominate artery: Proximal ligature; distal ligature of right carotid and the third part of the subclavian artery. Recovery.** (Gordon-Taylor.)

L. C., male, aged 56, was regarded by the physicians in attendance as suffering from an innominate aneurysm, and an invitation was extended to me to ligature the innominate artery. A pulsating tumour could be felt at the root of the neck and under the upper part of the thoracic wall on the right side. In October, 1937, a T-shaped incision was employed and the sternum split in the midline by a Liebsche chisel and the gladiolus sawn across with a Hey's saw opposite the second intercostal space. The aneurysm was not of very formidable dimensions and happily involved the distal part of the artery; a ligature was coaxed around the artery close to its origin from the aorta; a piece of tape was then substituted and a stay knot was tied.

The common carotid artery emerging from the superior surface of the aneurysm was then ligatured with silk. It proved impossible to identify and expose the first part of the subclavian artery, and the transverse portion of the incision above the right clavicle was therefore extended to the right, and the third part of the subclavian was tied. All pulsation ceased in the sac, and when the man was seen a year later in good health, the lump in the root of the neck was far smaller and no longer pulsated. He was still alive just before the outbreak of the last war in 1939, that is to say, two years after operation, but I can glean no information about him to-day.

Case 5.—**Aneurysm of commencement of right subclavian artery, aortic regurgitation: Ligature of innominate artery. Recovery** (Gordon-Taylor).

Mrs. C. J., aged 56, was admitted to Cardiff Royal Infirmary on Aug. 3, 1948, with pain and weakness of right arm and hand for past seven months and shortness of breath on exertion for the past two years. There was a swelling above the right clavicle exhibiting expansile pulsation, and a right Horner's syndrome was also apparent. Blood Wassermann and Kahn reactions strongly positive.

PAST HISTORY.—Partial thyroidectomy had been performed in Porth Hospital two years before. Radiotherapy for menorrhagia four years previously. Mother alive, aged 75, has been blind for twenty-three years. Father died at 65, " heart trouble ".

Obstetric History.—Two miscarriages. Two children dead, one at 3 months (fits), one at 14 years 11 months (mentally defective). Two alive and well, male aged 22, female aged 19.

Just before admission the pain in the right arm became so severe that she was receiving two injections of morphine daily. Pain extended to shoulder and chest. Blood-pressure: left, 125/85; right, 170/40.

OPERATION (Aug. 27).—Sir Gordon Gordon-Taylor, assisted by Professor Lambert Rogers, placed a proximal ligature around the innominate artery after splitting the manubrium sterni. The artery was large and degenerated: it was tied with a ' stay knot ' of heavy braided silk, an endeavour being made not to rupture the coats. All pulsation in the aneurysm at once ceased, but returned in a day or two, although more feeble than before the operation.

The anæsthetic employed was intratracheal nitrous oxide and oxygen (Dr. Mushin).

Three weeks later, Sept. 14, 1948, it was decided to ligature the right common carotid. This was performed under 1 per cent procain anæsthesia, the carotid being divided between ligatures.

The aneurysmal condition of the neck was not greatly improved by these surgical measures, and the pulsation appeared to extend more laterally towards the anterior border of the trapezius. The pain in the arm and shoulder was somewhat less severe than it had been.

Pulsation was felt in the upper abdomen in the very commencement of 1949, and a diagnosis of an abdominal aneurysm was confidently made.

Despite anti-luetic measures and other therapy directed to her cardiovascular system, the patient gradually failed and succumbed at home about twelve months after the surgical treatment of her aneurysm.

Cases operated upon by Other Surgeons

a. Holmes Sellors (1935).—

Bifurcation aneurysm of the innominate involving origin of carotid and subclavian arteries: Proximal ligature of innominate. Recovery.—An elderly man attended hospital with an expansile pulsating swelling in the base of the neck on the right side. This swelling could be felt passing behind the suprasternal notch. Wassermann positive.

It was decided first to tie the artery proximally and consider distal ligature of carotid and subclavian later. This latter, however, was declined by the patient when the time came.

OPERATION.—The clavicle was disarticulated at the sternoclavicular joint (right) and a tunnel dissection made (in very close quarters) behind the sternum. The aneurysmal swelling spread down as far as the aortic

arch, but it was not difficult to pass a ligature round the origin of the innominate artery. A tape ligature was used.

Ten years later the man attended Out-patients because the swelling in the neck had become more active and prominent. In view of his age and his strong disinclination to have anything done further operative treatment was not pressed.

Note.—With a very high aortic arch this limited approach was much easier than expected.

b. Holmes Sellors (1936).—

Aneurysm of innominate artery: Proximal ligature. Recovery from operation.—A middle-aged man came to hospital complaining of pain under the sternum and presenting a slight swelling over the upper part of this bone to the right of the midline. On examination this was found to be produced by a mass in the upper mediastinum which on screening pulsated, yet it could not be determined whether the pulsation was transmitted or truly expansile. The mass was eroding sternum and upper two ribs, and could also be felt behind the clavicle at the base of the neck.

OPERATION.—The chest was opened by an osteoplastic flap through the left costal cartilages with the incision carried across the sternum in the 3rd interspace. The flap was very gently lifted up, and the eroding aneurysm visualised as a large swelling arising almost directly above the arch of the aorta. The base of the sac, i.e., innominate artery, was encircled and tied with a massive stay suture of silk. Pulsation was markedly reduced and convalescence was straightforward with loss of pain. The patient left hospital, but about 2 *months later* attended Out-patients with extreme tightness and shortness of breath which was progressive over a period of 10 to 14 days until he died. At the autopsy it was found that the ligatures round the aorta had cut completely through, leaving a hole in the aorta. From this apparently a massive hæmorrhage had occurred, but since this had taken place into an enclosed space the whole upper mediastinum was a mass of gelatinous clot.

Complete specimen was kept showing the ligature lying against the aorta, but it unfortunately was destroyed during the bombing of 1940–1.

c. Holmes Sellors (1941).—

Aneurysm of the innominate artery: Proximal ligature. Recovery. A middle-aged labourer, X-rayed because of pain in the chest and slight loss of voice, was thought to have a mediastinal tumour, i.e., expansile pulsation was not demonstrated.

OPERATION.—The chest was explored through a posterolateral incision (*Fig.* 519) and a tumour, the size

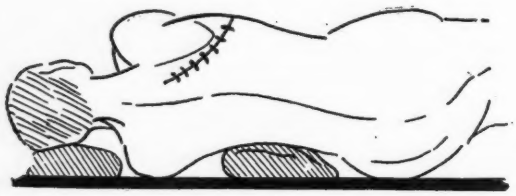

FIG. 519.—High (4th rib) posterolateral thoracotomy for reaching the upper mediastinum and applicable to the operation of innominate ligature for aneurysm.

of a tangerine, found in the upper mediastinum. At first sight it looked like a malignant mass, but on further discussion was seen to be an innominate aneurysm, solid and apparently largely clotted. The wide opening of the innominate, which was slightly involved in the swelling, was encircled with tape and gradually and carefully tightened. It must, however, be admitted that the degree of pulsation was not marked, for ligature produced only a slight diminution. There was some post-operative mental confusion for a few days, but no paralysis. The patient was lost sight of during the latter years of the war, but was well when last heard of.

Possibly the spontaneous clotting in this case prevented the classical signs of aneurysm, and ligature may not have been necessary.

d. Holmes Sellors (1948).—

Aneurysm of an innominate artery which gave origin to both carotid and right subclavian: Proximal ligature. Death.—A middle-aged woman was admitted to Middlesex Hospital with a swelling in the upper mediastinum and pulsation in the base of the neck. The swelling under short period of observation became appreciably bigger.

OPERATION (May, 1948).—A posterolateral transpleural approach was employed and exposed a big aneurysm arising close to the aortic arch. The size of the aneurysm was that of a grapefruit, but on dissection a normal-sized origin of innominate, ½ in. long, was found. The next vessel to the left was dissected and was presumed to be the left common carotid. The innominate was then tied. The patient died shortly after, never having properly regained consciousness, and at autopsy it was ascertained that the left common carotid came off the innominate and that the normal vessel felt was actually the left subclavian (*see Figs.* 512, 513).

Grey Turner (1925).—

Large aneurysm of right subclavian artery: Innominate artery tied and divided between ligatures. Death fifteen hours after operation; tension pneumothorax.—Inner end of clavicle removed and part of sternum to aid exposure: medial part of the very well-defined sac had to be gently retracted laterally to enable surgeon to gain access to the innominate. Artery ligated and divided between ligatures of chromic catgut. Very noisy respiration throughout and much sucking of air into the cellular tissues. Post-mortem: a middle-aged male—a tension pneumothorax with collapse of the lung. "The trachea is the guide to the artery" (Grey Turner).

J. N. Jackson Hartley (1931).—

Spontaneous aneurysm of the innominate artery, wrapped round by fascia lata. Recovery.—Female, aged 63. Admitted to the Cumberland Infirmary, December, 1931, with a pulsatile swelling extending a little above the right sternoclavicular joint. The pulsation was visible and the patient was very conscious of it. Operation on Dec. 21. Division of sternal head and part of clavicular head of sternomastoid and the depressor muscles afforded adequate access: fusiform aneurysm of innominate at its bifurcation: a long strip of fascia lata was wound around the arterial bulge. By suturing the edges of adjacent fascial turns Hartley succeeded in restoring a fairly uniform calibre to the artery. Recovery was uneventful. She died a year later from causes unconnected with her operation.

Sir Cecil Wakeley (1916).—

Traumatic aneurysm of innominate artery: Proximal ligature. Recovery.—George H., a seaman, aged 24, was hit while in a destroyer at the Battle of Jutland, 1916, by a small piece of high explosive just above the inner end of the right clavicle. The entrance wound was small and the patient 'carried on' and did not complain of any pain until six weeks later, when he was sent to hospital because of a small pulsating swelling which could be felt in the suprasternal notch. While in hospital the swelling became larger and X rays revealed a saculated aneurysm of the innominate artery.

Operation was decided upon and under general anæsthesia on July 21 the base of the innominate artery was tied with thick silk. The manubrium sterni was split and a counter-incision made across the base of the manubrium at the level of the second costal cartilage.

Table I.—LIGATURE OR ATTEMPTED LIGATURE OF INNOMINATE ARTERY FOR INNOMINATE ANEURYSM

SURGEON	YEAR OF OPERATION	ANEURYSM		SEX AND AGE	SURGICAL PROCEDURE	RESULT
		Nature	*Situation*			
1. KEY, C. Aston (Guy's Hospital) (1844)	1844	Spontaneous	Distal innominate + origin subclavian artery	F. 46	*Attempted* ligation of innominate—abandoned after ¾ hour	*Death* on 23rd day from pressure on bronchus
2. COOPER, E. S. (San Francisco) (1859)	1859	Spontaneous	Bifurcation of innominate, involving carotid and subclavian	—	Ligation of innominate	*Died* of uræmia on 9th day
3. HELFERICH (Greifswald)	1890	Spontaneous	Bifurcation of innominate artery	M. 39	*Attempted* ligation of innominate. Artery could not be found. Sac which had been opened was packed with gauze	*Death* on 16th day — secondary hæmorrhage, infection, and pneumonia
4. PARHAM, J. (New Orleans) (1895)	1894	Spontaneous	Bifurcation of innominate involving three vessels	M. 48	*Attempted* ligation of innominate (carotid, internal and external, previously ligated)	*Death* 17 hours after operation
5. BURRELL, H. L. (Philadelphia) (1895)	1895	Spontaneous, fusiform	Bifurcation, involving carotid and subclavian	M. 54	Innominate ligated with flat braided silk in two places	*Recovery*, but died suddenly on 104th day. Innominate artery completely closed at bifurcation. Ligature embedded in artery wall
6. GAY, G. W. (Boston City Hospital, U.S.A.) (1877)	1896	Spontaneous	Bifurcation	F. 39	Innominate ligated with three ligatures of braided silk	Carotid tied 32 days later for hæmorrhage. *Death*
7. BENNETT, A. L. (1900)	1898	Spontaneous	Bifurcation	M. 55	Innominate artery divided between tape ligatures	*Death* 3 days later from hæmorrhage
8. SCHUMPERT, T. E. (Shreveport, Louisiana) (1898)	1898	Spontaneous	Bifurcation	F. 42	Ligation of innominate with braided silk	*Death* on 6th day with cerebral symptoms
9. DELAUP, S. P. (New Orleans) (1901)	1900	Spontaneous	Bifurcation, fusiform aneurysm involving 3 arteries	M. 58	Ligation of innominate	*Death* on 18th day during operation for secondary hæmorrhage, when carotid and vertebral were tied. The silk ligature on the innominate artery was in the lumen, the kangaroo ligature was absorbed.
10. BALLANCE, Sir Charles (St. Thomas's, London)	1902	Spontaneous	Bifurcation aneurysm of innominate, involving carotid and subclavian	M. 35	Ligation of innominate. Four strands of gold-beaters' skin, No. 4. Common carotid ligated with two strands of gold-beaters' skin	*Death* on 2nd day from left hemiplegia
11. HALSTED, W. S. (Baltimore)	1907	Spontaneous	Bifurcation aneurysm, involving subclavian and carotid	M. 51	Ligation of innominate artery with three heavy braided silk ligatures	Aneurysm continued to pulsate with two-thirds former force. Aluminium bands placed round carotid and innominate, 18th day. *Survived 11 months*
12. KIMURA (Japan)	1908	Spontaneous	Bifurcation aneurysm	M. 46	Innominate, subclavian, and carotid doubly ligated and sectioned between silks. Sac partly removed	*Cure* at 17 months
13. BALLANCE, Sir Charles (St. Thomas's, London)	1909	Spontaneous	Bifurcation	M. 35	Sac torn. Innominate ligated with two kangaroo tendon ligatures—stay knot	*Death* 30 hours later
14. SARGENT, Percy (St. Thomas's, London) (1911)	1909	Spontaneous	Distal part of innominate	F. 67	Ligation of innominate and carotid. Two floss silk ligatures on innominate—stay knot	*Recovery*. Death 17 months later of pneumonia and nephritis
15. LESSNOI, S. (Moscow) (1928)	1915	Traumatic	Innominate, involving commencement of carotid	M.	Ligation of innominate	*Recovery*
16. WAKELEY, Sir Cecil (King's College Hospital)	1916	Traumatic	Aneurysm of innominate artery	M. 24	Ligation of innominate with thick silk	*Recovery*
17. HAMMANN, C. A. (Cleveland, Ohio) (1916)	1916	Spontaneous, fusiform: the three vessels dilated to three times their normal size	Bifurcation	F. 59	Ligation of innominate with heavy silk. Carotid with chromic catgut	*Death* on 4th day—hemiplegia
18. REID, Mont. (Baltimore and Cincinatti) (1926)	1918	Spontaneous	Involving origin of innominate	M. 45	*Attempted* ligation of innominate	*Death* on table
19. HALSTED, W. S. (Baltimore)	1918	Traumatic	False aneurysm of innominate artery: urgent operation	M.	Wound of superior surface of innominate artery sutured with 0 chromic catgut	*Recovery*
20. BALLANCE, Sir Charles (St. Thomas's, London)	1918	Spontaneous	Distal part of innominate artery	F. 60	Innominate artery ligated with two strands of kangaroo tendon without rupturing artery coats	*Recovery*. Died 2½ years later of cardiovascular break-down. Aneurysm gone: artery obstructed
21. MATAS, Rudolf (New Orleans)	?	Spontaneous	Innominate artery	?	Metal band about innominate artery	*Death* on 6th day from hæmorrhage and pulmonary complications

Continued on next page

Table I.—LIGATURE OR ATTEMPTED LIGATURE OF INNOMINATE ARTERY FOR INNOMINATE ANEURYSM, *continued*

SURGEON	YEAR OF OPERATION	ANEURYSM		SEX AND AGE	SURGICAL PROCEDURE	RESULT
		Nature	*Situation*			
22. MATAS, Rudolf (New Orleans)	?	Spontaneous	?	?	Metal band	*Recovery*
23. MATAS, Rudolf (New Orleans)	?	Spontaneous	?	?	Metal band on innominate	*Recovery*
24. MATAS, Rudolf (New Orleans)	?	Spontaneous	Fusiform	?	Ligature of innominate	*Death*
25. SAUERBRUCH, F. (Munich)	1918	Small grenade wound of innominate artery		M.	Suture of innominate artery	*Death* from suppurative mediastinitis 5 days later
26. GREENOUGH, Jas. (Cooperstown, N.Y.) (1929)	1924	Spontaneous fusiform	Distal innominate and subclavian	F. 45	Ligation of innominate carotid and subclavian	*Recovery*. Well 7 months later
27. BALLANCE, Sir Charles (St. Thomas's, London)	1925	Spontaneous	Distal	?	Proximal ligation of innominate. Years later ligature of carotid and axillary	*Recovery*, and survived 7 years—dying from rupture of aneurysm
28. SAUERBRUCH, F. (Munich)	1925	Hæmorrhage from a thyroidea ima arising from innominate during removal of calcified tumour from thoracic inlet		?	A suture of the contused wall of innominate, including origin of thyroidea ima	*Recovery*
29. GORDON-TAYLOR, Sir Gordon	1927	Spontaneous	Distal	M. 43	Proximal ligature	*Death* 7 days after from hæmorrhage from sac
30. FLINT, E. E. (Leeds) (1928)	1927	Traumatic	Bifurcation of innominate artery	M. 37	Ligation of innominate and transsaccular ligation of subclavian. Packing	*Cure* and well 6 months later
31. JACKSON-HARTLEY, J. N. (Carlisle)	1931	Spontaneous	Bifurcation	F. 63	Strip of fascia lata wound round arterial bulge (fusiform)	*Recovery*. Death 1 year later from unconnected causes
32. SOUTTAR, H. S. (London Hospital) (1934)	1933	Spontaneous	Aorta dilated, pushing aneurysm into neck	F. 62	Ligation of innominate and subclavian	*Well* 16 years after
33. LEXER, E. (Munich) (1934)	1934	Traumatic	Arteriovenous	M. 24	Transvenous suture of innominate artery. Ligation of innominate vein	*Death* from infection 17 days later
34. TURNER, William (Westminster Hospital, London)	1934	Spontaneous	Innominate	M. 67	Carotid, vertebral, and subclavian arteries had all been ligated previously: ineffective. *Attempt* to ligate innominate unsuccessful	*Death*
35. CARLING, Sir Ernest Rock, and EDWARDS, Tudor (Westminster Hospital)	1934	Spontaneous	Distal portion of innominate	F. 64	Ligation of innominate (1934) by Tudor Edwards. Recurrence. Excision of reduced sac after ligation of innominate carotid and subclavian	*Recovery*
36. CARLING, Sir Ernest Rock	1934	Spontaneous	?	F. 49	Innominate, carotid, and subclavian all doubly ligated. Sac not excised	*Paresis*, but patient alive two years later
37. SELLORS, T. Holmes (Middlesex Hospital)	1935	Spontaneous	Bifurcation aneurysm	M. Elderly	Proximal ligature. Subsequent distal ligature declined	*Alive* 10 years after, but swelling in neck active again
38. SELLORS, T. Holmes (Middlesex Hospital)	1936	Spontaneous	Innominate aneurysm	M. 50	Innominate ligatured with massive silk—stay knot	*Recovery*. 2½ months later died and, P.M., ligatures around aorta had cut completely through, leaving a hole in aorta
39. GORDON-TAYLOR, Sir Gordon (Middlesex Hospital)	1936	Spontaneous	Innominate coming through chest wall	M. 44	Proximal ligation of innominate	*Death* from intercurrent illness 6 weeks after operation. Sac filled with clot
40. MEADE, Harry (Dublin) (1941)	1936	Spontaneous	Distal innominate involving subclavian	M. 65	Strips of fascia lata around innominate and subclavian	*Improved*, but pulsation persisted
41. GORDON-TAYLOR, Sir Gordon	1936	Spontaneous	Distal	M. 56	Proximal ligation of innominate. Ligation of carotid. Ligation of 3rd part of subclavian	*Recovery*. Alive 3 years later
42. BROCK, R. C. (Guy's Hospital, London) (1940–1)	1939	Spontaneous	Distal and involving bifurcation	M. 66	Ligation of innominate with two stout linen thread ligatures	*Death* 5 weeks after operation. Ligatures securely in place; lumen of artery satisfactorily obliterated. Hæmorrhage had come from junction of internal mammary and sac
43. SELLORS, T. Holmes (Middlesex Hospital)	1941	Spontaneous	?	Middle-aged	Ligature of innominate artery with tape	*Well* 4 or 5 years later
44. LANGLEY, G. F. (Ipswich)	1943	Traumatic	?	M.	Triple ligature	*Death* 12 hours after with cerebral symptoms

45. TRENT, J. C. (Ann Arbor, Michigan)	1944	Spontaneous		M. 52	Innominate artery ligated with two rubber bands	*Recovery*
46. ELKIN, D. C. (Atlanta, Georgia)	1945	Traumatic	Arteriovenous fistula of innominate vessels	M. 25	Proximal and distal division of innominate artery. Ligation and division of right innominate vein	*Recovery*
47. LINDSKOG, Gustaf E. (Yale Univ. Sch. of Med., New-haven, U.S.A.)	1945	Traumatic	Large fusiform dilatation of innominate artery	M. 27	Digital compression of and subsequent ligation of common carotid. Innominate ligated with umbilical tape, and also by braided silk	*Recovery*
48. GORDON-TAYLOR, Sir Gordon	1945	Traumatic	Arteriovenous aneurysm of innominate vessels	M. 37	Proximal ligation of innominate artery and suture of sac. Subsequent ligation of carotid and first part of subclavian	*Cure*
49. SHUMACKER, Harris B. (Yale Univ. Sch. of Med., New-haven, U.S.A.)	1945	Traumatic	Saccular aneurysm of innominate involving considerable length of vessel	M. 25	Preliminary partial ligation with fascia and cellophane—sympathectomy. Later, carotid and subclavian divided. Innominate artery ligated with tape and sac evacuated	*Recovery*
50. SELLORS, T. Holmes (Middlesex Hospital)	1948	Spontaneous	Aneurysm of innominate artery	F.	Supposed ligature of innominate, but innominate and left carotid came off from a common stem	*Death* without regaining consciousness
51. GORDON-TAYLOR, Sir Gordon (Middlesex Hospital) Operation in Cardiff	1948	Spontaneous	Bifurcation aneurysm of innominate	F. 56	Ligature of innominate. Subsequent ligature of carotid	*Recovery*, but later pulsation returned in posterior triangle of neck. Also aneurysm of descending aorta. Death 1 year after.
52. SKAPINKER, S. (Johannesburg)	1948	?	Bifurcation aneurysm of innominate. Rapidly enlarging	M. 30	Proximal ligature of innominate with two ligatures of No. 8 twisted black silk	*Recovery*

30 recoveries : 22 deaths. Percentage of recoveries 57·7 per cent.

Patient made an uninterrupted recovery. Was seen again in 1917, when he was still in the Navy and was quite fit.

C. J. MacAuley (1933).—

Ligation of the innominate artery for subclavian aneurysm. Recovery.—Mrs. B., aged 53, was admitted to the Mater Misericordiæ Hospital, on March 15. She complained of intense pain and throbbing in the right shoulder and arm, and of loss of power in the arm.

There was a pulsating swelling, the size of a hen's egg, above the right clavicle. No bruit could be heard over the swelling, and no pulse could be felt in the right arm. The blood Wassermann was negative, and the heart was radiologically normal.

The swelling, when exposed by an incision above the clavicle, was seen to extend under the scalenus anterior muscle. The incision was continued downwards over the sternum, and the inner end of the clavicle, together with the sternal end of the first costal cartilage and the right half of the manubrium sterni, was removed. The innominate artery was cleared and doubly ligated with stout linen thread tied in a Ballance and Edmunds ' stay knot '.

The patient made a good recovery, and was discharged on May 25.

When shown at the Surgical Section of the Royal Academy of Medicine in Ireland, on Feb. 5, 1937, she stated she had been in good health and free from pain since the operation.

a. A. E. Coates, of Melbourne (1932).—Subclavian aneurysm in a man of 50, who had sustained a fractured clavicle some years before. He had endured very severe pain from pressure of the aneurysm on the brachial plexus ; muscular wasting of the right hand and forearm present. The right common carotid was first ligated, and the innominate artery was drawn up from the chest and a ligature applied. The result was excellent and the man is now (1949) a woodcutter in Gippsland (Victoria).

b. A. E. Coates (1935).—An elderly woman referred by Dr. Keith Fairley with a pulsating tumour at the root of the neck. Ligature of innominate artery. Death, with cerebral symptoms.

c. A. E. Coates (1940).—A lady of 59 with a large aneurysm of the common carotid artery at the root of the neck ; severe pain ; Horner's syndrome ; recurrent laryngeal nerve pressure. Innominate artery ligated. Immediate result good. Recurrent laryngeal palsy cleared up. Some months later she was said to have died of a ' stroke '.

d. A. E. Coates (1946).—Girl of 17. Congenital arteriovenous hæmangioma involving right arm and shoulder ; patches of ' pulsating angioma ' on forearm, arm, shoulder, and neck. Had a considerable hæmorrhage from patch on arm, when at her work. A mass on arm and forearm resected. Bruit noted in right subclavian area. Mass over shoulder later resected ; secondary hæmorrhage ; *innominate artery ligatured* ; hæmorrhage controlled. Subsequently wide excision of plexiform tortuous mass of vessels over shoulder and in neck. Breast swung over to cover raw area. Later a plastic operation by Mr. B. Rank and breast replaced in normal position.

Arteriovenous Aneurysms necessitating Interference with the Innominate Artery.—Till the present only three cases had been recorded in which an arteriovenous communication between the innominate artery and vein or between the very commencement of the subclavian artery and vein demanded surgical interference with the innominate artery :—

1. Emil Holman (1927), while operating on a subclavian arteriovenous aneurysm, had to combat

a rupture of the sac during the dissection, and a proximal ligature of the innominate artery was required as an emergency procedure.

2. In Lexer's case (1934) a transvenous suture of the fistula was attempted, but the patient succumbed days later from streptococcal sepsis.

3. In Dan Elkin's case, in 1945, a double ligation of the innominate artery was employed as well as a ligature and division of the right innominate vein: the patient underwent a complete cure. Two personal cases are now added, both of which ended successfully.

Case 6.—**Case of arteriovenous aneurysm of the innominate artery communicating with the left innominate vein. Recovery.** (Gordon-Taylor).

F. G., male, aged 37, German prisoner-of-war, was admitted to St. Margaret's Hospital, Epping, on May 6, 1945. In August, 1942, he had sustained injuries to the head, neck, and right cheek from the explosion of a bomb. He soon returned to work, but in November, 1942, was drafted to the Russian 'front', where he began to suffer from persistent faintness, fatigue, fever, pains in the chest, and swelling of the hands and fingers. After spending six months in hospital, where electrocardiograms and B.M.R. estimations were done, he was discharged from the German Army.

On Feb. 27, 1945, during a British air-attack he was hit in the left shoulder, neck, and right leg, and again wounded in the ambulance conveying him to hospital. During March, 1945, a fragment was removed from the right knee, which was infected, and in April he was transported as a prisoner-of-war to England. On admission to St. Margaret's Hospital he had an infected knee-joint, consolidation of the base of the left lung, and a wound of the left side of the neck; there was a soft pulsating swelling apparently arising in the chest, extending into the neck above the left clavicle, and filling the whole of the left supraclavicular fossa; this was capable of being emptied by pressure of the hand. The right arm was swollen and œdematous.

The heart was enlarged and there were signs of cardiac strain: a systolic thrill could be felt along the right subclavian, in the right common carotid, the axillary, and the brachial artery at the elbow. A good deal of œdema was present over the upper right side of the chest, extending across the middle line; all the superficial veins were very considerably dilated.

The patient's chief complaint was of pain in the neck, and he was apparently only comfortable while resting in bed. The information was elicited that ever since the first 'incident' he had been troubled with progressive breathlessness, and his arteriovenous aneurysm possibly dated from 1942.

The following note was made soon after the patient's admission, by a cardiologist: "The swelling above his left clavicle is about the size of a walnut and associated with a long systolic thrill; there is a more prominent thrill above the right clavicle. Distended veins reach nearly up to the right jaw, but these are more remarkable for their widespread distribution than for their individual size. Anæmia is marked.

"Heart: There is a diffuse thrill in the aortic area with a 'humming-top' murmur on the right side of the chest, especially above the right clavicle, extending down the right arm to the elbow. No murmur is heard in the left arm, and no murmur along either femoral artery; there is a good femoral pulse. The heart's apex beat is pushed outwards; clubbing of the fingers is absent. Blood-pressure in the right arm is 80/70; left arm is 130/70."

The man was kept under observation for several weeks; an abscess on the left side of the neck was drained, and a bomb-fragment removed. The patient's general condition deteriorated, and a second cardiological note stated that the œdema in the right arm was increasing and the swelling over the right clavicle was about twice its former size and easily collapsible.

X-ray examination showed considerable hypertrophy of the right side of the heart with some hypertrophy of the left.

Circulatory observations courteously carried out by means of cardiac catheterization (June 19, 1945) by Dr. Sharpey-Schafer and Dr. Sheila Howorth, of the Department of Medicine, British Post-graduate Medical Federation, demonstrated that the man had a very high pressure in the left innominate vein, where the blood was nearly arterial in composition. Mixed blood from the right auricle enabled these observers to calculate the cardiac output as 8·3 litres per minute, in contrast to the average normal 5·3 litres per minute.

Jugular venous pressure—pulsation at angle of jaw with patient flat with two pillows. Collapsing pulse in both arms. Resting rate 80–108. Aneurysm: small lump, 1 in. in diameter, pulsatile, collapsible, not constant in size, just medial to left sternomastoid immediately above the clavicle. Thrill and continuous murmur maximal over right clavicle just lateral to sternomastoid.

Diagnosis: Arteriovenous communication between innominate artery and left innominate vein. Pyelectan injected into antecubital vein only entered superficial thoracic veins.

Circulatory Observations made by Cardiac Catheterization (*June* 19).—

Position of Catheter	*Pressure (cm. saline above Sternal)*	*Oxygen Saturation of Blood*
1. Left innominate vein	+ 11·5	92 per cent (nearly arterial)
2. Internal jugular vein and subclavian junction		64 per cent normal venous blood
3. Mouth of inferior vena cava	+ 6·0	79 per cent
4. Right auricle	+ 5·5 (Normal) (= − 4)	78 per cent
5. Superior vena cava		81 per cent
6. Junction of two innominates		82 per cent
7. Internal jugular vein and subclavian junction		68 per cent

Cardiac output = 8·3 litres per min. (average normal 5·3)
Arteriovenous oxygen difference = 37·5 c.c. (normal = 43·0 c.c.)

OPERATION (July 19).—Anæsthesia was by means of omnopon and scopolomine and cyclopropane. Operation by Surgeon Rear-Admiral Gordon Gordon-Taylor, with the assistance of Messrs. H. W. S. Wright and S. M. Cohen. A somewhat curved incision was made over the upper part of the sternum down to the bone, and a flap was dissected upwards laterally on either side. A considerable amount of time was spent on this step because of the vascular engorgement of the skin and underlying tissues. The sternum was divided transversely with a Gigli saw at the level of the 3rd intercostal space and split from the suprasternal notch down to the line of trans-section by a Liebsche chisel, the two sides of the sternum being then separated by means of a Tuffier rib spreader. A great deal of matting of the tissues inside the thorax was encountered.

The precise site of the arteriovenous communication was not easy to localize, and the presence of a 'varicose aneurysm' overlying the anterior aspect of the aortic arch made progress slow, and three-quarters of an hour were spent in separating this sac from the aortic wall and displacing it upwards so as to expose the origin of the innominate artery (*Fig.* 520).

The innominate artery was ligated proximal to the aneurysm by means of a 'stay knot' of two pieces of strong plaited silk. The right pleural cavity, which had been slightly opened, was closed. Pulsation ceased in the aneurysmal sac at once and also disappeared from the right common carotid and subclavian; the fragments

of sternum were approximated with kangaroo tendon. The skin was sutured with interrupted stitches.

During the operation the aneurysm sac was accidentally broached and a considerable amount of trouble was encountered in repairing the tear, the patient losing about 1½ pints of blood.

For the next month the man's general condition gave rise to no grave anxiety, save for some elevation of temperature; he developed a collection of bloody fluid

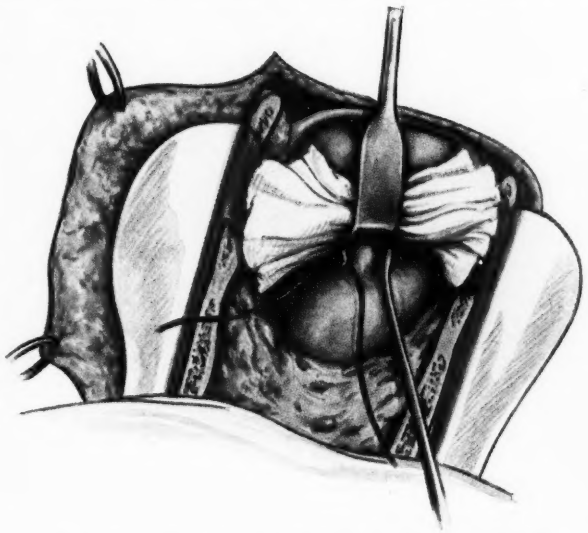

FIG. 520.—*Case* 6. Arteriovenous aneurysm involving innominate artery and probably left innominate vein. Sac with care and difficulty separated and retracted upwards from aortic arch. Aneurysm needle passed around origin of innominate artery. Left innominate vein hidden behind sac.

in the right pleural cavity and obviously had some pulmonary collapse and basal pneumonia. The pleuropulmonary complications cleared up with aspiration and other appropriate treatment. The right radial pulse remained imperceptible; the swelling of the right arm disappeared and in two weeks the limb had resumed its normal size. Unfortunately, the murmur which had previously been easily audible above the right clavicle and had disappeared after the operation now returned.

SECOND OPERATION (Aug. 14) (G. G.-T.).—The patient was again given pentothal, gas and oxygen, and cyclopropane. An incision was made along the posterior border of the sternomastoid and carried laterally along the clavicle. The clavicular part of the sternomastoid and scalenus anticus were divided and the first part of the subclavian found with considerable difficulty, after dividing the vertebral vein. The subclavian was ligatured with two ligatures of plaited silk; the vertebral artery was not tied. The operation proved tedious; the murmur again completely disappeared on ligaturing the subclavian artery. The general condition of the patient had marvellously improved and instead of being confined to bed the man could get about the hospital grounds actively.

Once again, however, the murmur returned in greatly diminished intensity, and the common carotid was kindly ligated and divided for me by Mr. H. W. S. Wright.

The murmur and thrill now completely disappeared, and the patient was able to run and take vigorous exercise without embarrassment. This happy state of affairs persisted to the date of his repatriation, and in the latter part of 1949 he was well. It will be noted that the exact point of communication between the artery and vein was never identified and neither innominate vein was in fact ligated. The disappearance of the 'humming-top' murmur and the complete change in the general well-being of the man appeared to confirm the adequacy of the surgery in this particular case.

Case 7.—**Arteriovenous aneurysm of first part of subclavian: Ligature of innominate artery, right innominate, and jugular veins. Recovery.** (Gordon-Taylor).—

Reginald V., aged 38, on June 22, 1948, fell about 30 ft. from a ladder and was admitted to hospital with the following injuries:—

a. Fracture of the middle third of the right clavicle;

b. Fracture of second right rib anteriorly and posteriorly;

c. An extreme degree of surgical emphysema.

The man was rendered unconscious for fifteen minutes by the fall. The surgical emphysema which on admission extended from the level of the right ear to the scrotum and later spread to both sides of his body and face, even involving the mediastinum, had disappeared by the first week in July.

On July 8, 550 ml. of sterile blood-stained fluid were aspirated from the left chest, and an additional 350 ml. a week later. At this juncture a harsh 'machinery'

FIG. 521.—*Case* 7. The dotted line indicates the area of maximum intensity of the 'machinery' murmur.

murmur was heard in the aortic area (*Fig.* 521), conducted along the great vessels in the neck to the mastoid process and also into the chest. The murmur was accentuated in systole and its maximum intensity was over the insertion of the sternal head of the sternomastoid. The murmur in the sternal and parasternal areas on the right side faded into the normal cardiac sounds and faded also in the left chest. Conduction occurred along the right clavicle to about midway along its length. At the junction of the inner and middle thirds of the clavicle on its upper surface was a palpable spicule of bone (*Fig.* 522) leading towards the area of maximal murmur—a marked thrill could also be felt at the root of the neck. At rest the patient showed

Table II.—Ligature or Attempted Ligature of Innominate Artery for Subclavian Aneurysm or Secondary Hæmorrhage

Surgeon	Year of Operation	Aneurysm		Sex and Age	Surgical Procedure	Result
		Nature	*Situation*			
1. Mott, Valentine (New York) (1818, 1819, 1820)	1818	Spontaneous	Subclavian aneurysm	M. 57	Ligation of innominate with "round silken" ligature, which came away 14th day	*Death*: 26th day. Sepsis; hæmorrhages
2. Graefe (Berlin)	1822	Spontaneous	Subclavian aneurysm of rapid growth	M. 30	Ligation of innominate. Silk ligature came away 14th day	*Death*: 67th day. Repeated hæmorrhages. Suppuration in sac
3. Norman (Bath)	1824	No aneurysm	Mistaken diagnosis of aneurysm of subclavian	M.	Ligation of innominate artery	*Death* on 5th day after operation from acute pericarditis
4. Arendt (St. Petersburg)	1827	Traumatic (?)	Subclavian aneurysm (1st part)	M. 36	Ligation of innominate	*Death* on 8th day—sepsis
5. Hall, J. (Baltimore) (1833)	1830	Spontaneous	Aneurysm of right subclavian	M. 52	*Attempted* ligation of innominate—ligatures had been passed through artery not round it	*Death* 5 days after—sepsis
6. Porter, W. H. (Meath Hospital, Dublin) (1832)	1831	Spontaneous	Aneurysm, probably subclavian, of 2½ years duration	M. 47	*Attempted* ligation of innominate. Operation abandoned after 1¼ hours owing to the difficulties produced by the sternum, the struggles and cries of the patient	*Recovery*—tumour ¼ size and firmer. Patient alive and well 7 years after
7. Bland, W. (Sydney, N.S.W.) (1832)	1832	Spontaneous	Aneurysm of subclavian	M. 31	Ligature of innominate "by two threads" so as to divide inner coats	*Death* on 18th day—hæmorrhages—sepsis. Hæmorrhage from subclavian distal to ligature
8. Bujalsky (St. Petersburg) (1841)	1833	Spontaneous	Aneurysm of right subclavian	M. 56	Ligation of innominate	*Death* 5 days after operation—sepsis
9. Bujalsky (St. Petersburg) (1841)	? 1833	Spontaneous	Subclavian aneurysm	?	Ligation of innominate	*Death* "shortly after operation"
10. A Paris Surgeon (quoted by Dupuytren)	1834	?	?	?	Ligation of innominate	*Death* on 3rd day—of hæmorrhage
11. Kuhl (Berlin)	1836	Tumour	Vascular malignant tumour both sides of forehead	F. 43	*Attempt* to ligate innominate artery, but carotid and subclavian ligated together in mistake	*Death* on 3rd day
12. Lizars, John (Edinburgh) (1837)	1837	Traumatic. Fractured clavicle	Subclavian aneurysm	M. 30	Ligation of innominate. Operation did not last 15 minutes	*Death* on 21st day—hæmorrhages. Innominate had separated at site of ligature
13. Hoffman (New York)	1839	Spontaneous	Subclavian aneurysm	M. 63	*Attempted* ligation of innominate. Innominate too diseased to ligature	*Death* from exhaustion 3 months later
14. Hutin (Paris) (1842)	1842	Traumatic	For hæmorrhage from wound of branch of axillary artery	M. 27	Innominate tied for secondary hæmorrhage after subclavian ligation	*Death* 11 hours later
15. Peixoto, A. J. (Rio de Janeiro)	1851	Tumour	For vascular erectile tumour of ear	M. 33	Innominate exposed for secondary hæmorrhage. Unfinished operation—ligature passed, but not tied	*Recovery*
16. Pirogov, I. (St. Petersburg) (1864)	1856	Spontaneous	Subclavian aneurysm	M. 46	Ligation of innominate	*Death* 48 hours after operation—sepsis
17. Gore, R. T. (Bath) (1878)	1856	Spontaneous	Subclavian and axillary aneurysm	M. 52	Ligation of innominate	*Death* on 17th day—hæmorrhage
18. Cooper, E. S. (San Francisco) (1861)	1861	Spontaneous	Probable subclavian aneurysm	M.	Ligation of innominate	*Death* on 34th day—recurrent hæmorrhages
19. Smyth, A. W. (New Orleans) (1864)	1864	? Traumatic	Subclavian artery	M. 33	Ligation of innominate and carotid. Ligature on carotid came away of 13th day	*Recovery*. Hæmorrhages on 14th, 33rd, and 51st days. Vertebral ligatured on 54th day
20. Lynch (New York) (1868)	1867	Traumatic. Gunshot wound of common carotid and vertebral	Aneurysm site of abscess	M.	Ligation of innominate for secondary hæmorrhage, common carotid having been tied one month before	*Death* 12 days later—ligature of innominate occupied 18 minutes
21. Porter, G. H. (Meath Hospital, Dublin) (1867)	1867	Spontaneous	Subclavian aneurysm	M. 43	Innominate compressed by instrument like a lithotrite	*Death* on 10th day—hæmorrhage
22. Bickersteth, E. R. (Liverpool) (1872)	1868	Spontaneous	Subclavian aneurysm	M. 40	Innominate ligated after a clamp had broken on artery	*Death* 7 days after ligature—hæmorrhage
23. Mott, A. B. (New York)	1868	Spontaneous	Subclavian aneurysm	M.	Innominate and carotid ligated	*Death*—ligature came away 23rd day—hæmorrhage
24. Partridge, S. B. (Calcutta) (1870–1)	1870	Spontaneous	Aneurysm of right carotid	M.	Ligation of common carotid. Ligature separated 13 days later. Hæmorrhage. Ligation of innominate for secondary hæmorrhage	*Death* 1½ hours later. Carotid open on cardiac side of ligature
25. O'Grady, E. S. (Mercers Hospital, Dublin) (1873)	1873	? Traumatic	Aneurysm of subclavian artery of 3 years' duration	M.	Ligation of carotid and innominate	*Death* 20 hours later—cerebral
26. Buchanan, G. (Glasgow) (1880)	1880	Spontaneous	Aneurysm of subclavian	M 40	Sac burst at operation—ligation of innominate	*Death* on table
27. Thomson, W. (Richmond Hospital, Dublin) (1882)	1882	? Traumatic	Aneurysm of 2nd and 3rd parts of subclavian	M. 49	Innominate ligated with ox-aorta	*Death* on 42nd day after several hæmorrhages: sepsis in drainage-

(1873) 26. BUCHANAN, G. (Glasgow) (1880)	1880	Spontaneous	Aneurysm of subclavian	M. 40	Sac burst at operation—ligation of innominate	*Death* on table
27. THOMSON, W. (Richmond Hospital, Dublin) (1882)	1882	? Traumatic	Aneurysm of 2nd and 3rd parts of subclavian	M. 49	Innominate ligated with ox-aorta	*Death* on 42nd day after several hæmorrhages: sepsis in drainage-tube sinus: ulceration of anterior wall of artery distal to ligature
28. BANKS, W. Mitchell (Liverpool)	1883	Spontaneous	Aneurysm of 3rd part of subclavian	M. 50	Innominate and carotid tied with kangaroo tendon; 67 days later 1st part of subclavian tied	*Death* 37 days after second operation—hæmorrhages. Innominate artery patent
29. BULL (New York)	1884	Spontaneous	Aneurysm of subclavian	?	Innominate, carotid, and vertebral ligated with double catgut	*Death* on 33rd day from hæmorrhage
30. ANNANDALE, Thos. (Edinburgh) (1886)	1885	Spontaneous	Aneurysm of 2nd and 3rd parts of subclavian	M. 53	Employed special 'compressor' for innominate. Hæmorrhage 11th day. Unsuccessful attempt to tie innominate	*Death* 5 hours later
31. MAY, Bennett (Queen's Hospital, Birmingham)	1886	? Traumatic	Involved all three parts of subclavian	M. 30	Ligation of innominate; 5 or 6 strands of medium catgut	*Death* 18 days later. Sepsis: hæmorrhages. A hole in the artery under the knot of the ligature
32. DURANTE, F. (Rome)	1887	Spontaneous	Aneurysm of 2nd part of subclavian	M. 45	Ligation of innominate, carotid, and vertebral	*Death* on 15th day. Sepsis, hæmorrhage, and hemiplegia
33. LEWTAS, J. (Punjab) (1889)	1889	Traumatic	Operation undertaken for supposed abscess and removal of F.B. Severe hæmorrhage	M. 26	Innominate and carotid tied with catgut as emergency measure	*Recovery*
34. TWYNAM, G. E. (Sydney, N.S.W.) (1890)	1889	Traumatic. Fracture of clavicle	Aneurysm of 1st part of subclavian	F. 18	Ligation of innominate and carotid with silk	*Death* next day—cerebral symptoms
35. JACOBSON, W. H. A. (Guy's Hospital) (1891)	1890	Spontaneous	Large aneurysm of 2nd and 3rd parts of subclavian	M. 48	Ligation of innominate and carotid with ox-aorta	*Death* 10 days after. Infection: bronchopneumonia
36. COPPINGER, Chas. (Mater Misericordiæ Hospital, Dublin) (1893)	1893	Spontaneous	Subclavian aneurysm		Ligation of innominate. Carotid divided between ligatures	*Recovery*—first in Europe
37. SYMONDS, Sir C. J. (Guy's Hospital)	1894	Spontaneous	Second part of subclavian	M. 53	Innominate and carotid tied with silk	*Lived some years.* Death "from a general malady"
38. HERNANDEZ, Alb. (Mexico) (1900)	1896	For primary hæmorrhage from stab wound at root of neck		M. 18	Ligation of innominate + a clamp distally	*Recovery*, but 6 years later a small pulsating tumour behind sternum
39. HARTE, R. H. (Philadelphia) (1897)	1897	For secondary hæmorrhage following gunshot wound	?	M. 26	Ligation of carotid 16 days after wounding. Ligation of innominate, carotid, subclavian, and internal jugular vein	*Death*
40. MOYNIHAN, Lord (Leeds) (1898)	1898	Spontaneous	Third part of subclavian	M. 31	Resection of aneurysm. Infection. Hæmorrhage. Ligation of innominate and carotid 5 weeks later	*Death* 1 hour after operation. A second aneurysm distal to the vertebral, which had ruptured
41. CURTIS, B. F. (St. Luke's Hospital, New York) (1900, 1901)	1899	Spontaneous	Subclavian	M. 55	Ligation of innominate; 3 months later carotid and 1st subclavian ligated	*Cure*
42. RUEDIGER, V. (Vienna) (1906)	1901	Spontaneous	Enormous aneurysm of subclavian	F. 37	Distal ligation of subclavian + ligation of innominate on account of difficulty of ligating 1st part of subclavian. Sac partly extirpated	*Death*
43. PERSONS (1904)	1903	Traumatic. Imperfect information		?	Unable to identify subclavian because of clot. Innominate artery ligated	*Death*
44. SHEEN, W. A. (Cardiff) (1905 a, b)	1904	Spontaneous	Second and 3rd parts of subclavian	M. 40	Ligation of innominate and carotid followed 8 weeks later by ligation of 1st part of subclavian	*Cure*
45. SAIGO, K. (Japan) (1906)	1904	Traumatic	Aneurysm of right common carotid	M. 22	Ligation of innominate artery; 7 months later swelling and murmur. Tinnitus: giddiness. Carotid tied above and below opening of sac. Resection of sac	*Recovery*
46. SAIGO, K. (Japan: Russo-Japanese War) (1906)	1905	Traumatic	Varicose aneurysm of right subclavian artery and vein	M. 25	Innominate artery doubly ligated and cut; 4 months later subclavian artery and vein doubly ligated. Resection	*Cure*
47. CUNÉO (Hôp. Lariboisière, Paris)	1905	Spontaneous aneurysm of ascending aorta	?	F. 49	Ligation of innominate	*Recovery*—really a distal ligation operation for aneurysm
48. HALSTED, W. S. (Baltimore)	1905	Spontaneous	Aneurysm of right subclavian	F. 50	Aneurysm wired in 1904. In 1905 innominate partially ligated with N.33 aluminium band; 2 months later subclavian ligated	*Recovery*; 16 years later aneurysm had disappeared
49. CURTIS, B. F. (St. Luke's Hospital, New York) (1907)	1907	Spontaneous	Subclavian	M. 59	Innominate ligated through split sternum. No. 4 chromic catgut	*Death* from pneumonia 4 days after
50. BURNS, W. B. (Memphis, Tenn.) (1908)	1907	Spontaneous	Involving 1st, 2nd, and 3rd subclavian	M. 27	Ligation of innominate with braided silk. Infective hæmorrhage. Ligature discharged from wound 21st day	*Recovery* after hæmorrhages on 14th, 15th, and 17th days
51. MYLES, Sir Thomas (Dublin)	1907	Spontaneous	Subclavian	M. 29	Ligation of innominate and carotid doubly ligated and divided	*Death*—sepsis—hæmorrhages. Ligatures had slipped from carotid

Continued on next page

Table II.—LIGATURE OR ATTEMPTED LIGATURE OF INNOMINATE ARTERY FOR SUBCLAVIAN ANEURYSM OR SECONDARY HÆMORRHAGE, *continued*

SURGEON	YEAR OF OPERATION	ANEURYSM		SEX AND AGE	SURGICAL PROCEDURE	RESULT
		Nature	*Situation*			
52. BALLANCE, Sir Charles	1911	Spontaneous	?	M.	Ligature of innominate artery	*Recovery*
53. HERZEN, P. (St. Catherine's Hospital, Moscow) (1916)	1908	Traumatic	Subclavian	M. 30	Innominate carotid and subclavian aneurysm resected	*Recovery*
54. MORF, Paul F. (Chicago) (1917)	1911	?	Aneurysm of 2nd part of subclavian	M. 55	Ligation of innominate with two kangaroo tendon ligatures. Also ligation of carotid	*Recovery*, but still pulsation
55. MORISON, Rutherford (Newcastle-on-Tyne) (1914)	1912	Spontaneous	Aneurysm of 2nd and 3rd parts of subclavian	M. 51	Ligation of innominate with thick silk: vessel diseased and accidentally opened	*Recovery*
56. HALSTED, W. S. (Baltimore)	1912	Spontaneous	Aneurysm of subclavian	M. 47	Ligation of innominate	*Recovery*. Patient had his subclavian tied 3 years before by Mayo
57. HAMMANN, C. A. (Cleveland, Ohio) (1914)	1913	?	Aneurysm of subclavian	F. 68	Ligation of innominate with heavy braided double silk suture. Ligature of carotid with catgut (No. 2)	*Cure*
58. THOMPSON, J. E. (Galveston, Texas) (1915)	1914	Spontaneous	Second and 3rd parts of subclavian	M. 46	Innominate ligated with narrow linen tape distal to origin of left carotid which arose from innominate	*Death* 6 weeks later. Sepsis and anæmia of brain
59. HAMMANN, C. A. (Cleveland, Ohio) (1916)	1915	Spontaneous	Aneurysm of subclavian	M. 25	Ligation of innominate with No. 5 braided silk, carotid with No. 3 catgut	*Recovery*
60. COUGHLIN, W. T. (St. Louis, U.S.A.) (1918)	1916	Spontaneous	Subclavian aneurysm	M. 27	*Attempted* ligation of innominate with band	*Death* on table
61. SINCLAIR, T. (Belfast)	1916	Traumatic	Lower part of carotid	M. Young	Innominate tied with a single No. 4 chromic catgut ligature	Distal ligation postponed. *Recovery*
62. COUGHLIN, W. T. (St. Louis, U.S.A.) (1918)	1916	Spontaneous	Aneurysm of right subclavian	M. 28	Innominate occluded one-half by aluminium band; 3 weeks later, innominate and carotid ligated	*Cure*—2 years later
63. MAKINS, Sir George (St. Thomas's, London) (1919)	1917	Traumatic	Aneurysm of subclavian	M. Young	Innominate artery clamped until 1st part of subclavian artery tied	*Death* at end of 3 hours
64. MAKINS, Sir George (St. (Thomas's, London) (1919)	1917	Traumatic	Aneurysm of 1st part of subclavian	M. Young	Ligation of innominate and 3rd part of subclavian	*Recovery*
65. GRIFFITHS, Sir Hugh (London)	1917	Secondary hæmorrhage from common carotid at root of neck, gunshot wound		M. Young	Innominate artery ligatured in ward of Army hospital during air-raid, with only light of 'hurricane lamp'	*Death* from septicæmia from many wounds 10 days later
66. BONNEY, Victor (Middlesex Hospital Military Hospital, Clacton-on-Sea)	1917	Secondary hæmorrhage from gunshot wound of root of neck	Subclavian, 1st part	?	Ligature of innominate	*Recovery*
67. GORDON-TAYLOR, Sir Gordon (61 Casualty Clearing Station, Ypres Salient)	1917	Secondary hæmorrhage from gunshot wound of neck and shoulder region, for which 'forequarter' amputation had been performed	Probably 1st part of subclavian	?	Ligature of innominate	*Death* from septicæmia several weeks after
68. HALSTED, W. S. (Baltimore)	1918	Spontaneous	Aneurysm at commencement of carotid	M. 45	Ligation of innominate; 3 months later carotid tied	*Cure*. Well 4½ years later
69. JUCKELSON (Kiev) (1925)	1919	Traumatic	Aneurysm at commencement of carotid	M. 30	Ligation of innominate, common carotid and subclavian. Part of sac removed	*Recovery*. Well nearly 6 years later
70. HERTZLER, A. E. (Halsted Hospital) (1923)	1922	Traumatic	Subclavian	M.	Innominate ligated with double linen close to bifurcation	*Recovery*; 2 months later carotid and vertebral tied
71. TURNER, G. Grey (Newcastle-on-Tyne)	1925	Spontaneous	Subclavian	M.	Innominate divided between ligatures of chromic catgut (No. 1)	*Death* 15 hours after from tension pneumothorax
72. HOLMAN, Emil (San Francisco) (1927)	1927	Traumatic	Subclavian arteriovenous aneurysm	M. 25	Sac ruptured during dissection. Innominate artery ligated as an emergency measure	*Cure*
73. CHAPMAN, C. L. G. (Grimsby, Eng.)	1929	?	Subclavian	?	Ligation of innominate and common carotid with two strands of kangaroo	*Cure*

		?		?		Cure
73. Chapman, C. L. G. (Grimsby, Eng.) (1929)	1929	?	Subclavian	?	Ligation of innominate and common carotid with two strands of kangaroo tendon	
74. Coates, A. E. (Melbourne)	1932	Spontaneous	Subclavian	M. 50	Ligature of innominate and right common carotid	*Excellent.* Well in 1949
75. Coates, A. E. (Melbourne)	1935	Spontaneous	Subclavian	F. Elderly	Ligature of innominate	*Death*: cerebral
76. Coates, A. E. (Melbourne)	1940	Spontaneous	Root of common carotid	F. 59	Ligature of innominate	*Recovery*, but died several months after
77. Wheeler, Sir William (Dublin and London) (1942)	1932	Traumatic	Subclavian	M. 35	Ligation of innominate. Three No. 2 catgut ligatures. Proximal ligation of subclavian impossible	*Recovery.* Died in 1940
78. MacAuley, C. J. (Dublin)	1933	Spontaneous	Subclavian	F. 53	Proximal ligation with stout linen thread	*Recovery.* Well 4 years after
79. Oldfield, Michael (Leeds)	1944	Traumatic	Aneurysm of 2nd part of subclavian	M. 24	Ligature of innominate axillary, carotid, and vertebral arteries	*Recovery*
80. Coates, A. E. (Melbourne)	1946	Secondary hæmorrhage from root of neck. Tumour removal		F. 17	Urgent ligation of innominate artery to control bleeding	*Recovery*
81. Gordon-Taylor, Sir Gordon (Middlesex Hospital)	1948	Traumatic, following fracture of right clavicle	Arteriovenous aneurysm involving 1st part of subclavian artery and junction of internal jugular and subclavian veins	M. 38	Ligation of innominate artery, right innominate and internal jugular veins. Forcipressure to sac and right subclavian vein, which was firmly adherent to callus	*Recovery*

37 recoveries : 44 deaths. Percentage of recoveries 45·5 per cent.

no obvious dilatation of veins or congestion in the neck, but on slight exercise the veins became dilated and pulsated over the right pectoral area. There was no cyanosis.

At the end of July, although feeling weak, he appreciated no real difference in strength or sensation between the right and left arms, but in the middle of August he noticed that the right hand was colder than the left and that his appreciation of sensation was more acute on the left side. The strength in the right arm and hand was noticeably diminishing.

FIG. 522.—*Case* 7. Arteriovenous aneurysm between first part of right subclavian artery and the junction between the right internal jugular and subclavian veins consequent on fracture of clavicle.

On flexing his neck to the right and turning his chin to the left he became disagreeably aware of a rushing sound which passed up behind the right ear and he was conscious of pulsation in the right side of his neck.

Blood-pressure : Oct. 25 { right arm, 110/48, left arm, 100/40.
Nov. 3 { right arm, 125/65, left arm, 130/70.

Electrocardiogram was normal (Dr. G. E. S. Ward).

Cardiac catheterization (Dr. Wallace Brigden, Post-Graduate Hospital, Hammersmith) :—

1. Oxygen content : right auricle, 172 c.c. in 1 tetu.
sup. vena cava, 185 c.c. in 1 tetu.
left auricle, 150 c.c. in 1 tetu.

Conclusion : "There is an obvious mixture of arterialized blood to bring sample up to superior vena cava sample."

2. "The cardiac output was high, as might be expected, and was approximately 10 litres per minute at rest. This, together with the high auricular pressure, shows that there is definite overload. Presumably it would be wise to rectify this state of affairs as soon as reasonably possible" (Wallace Brigden).

OPERATION (Middlesex Hospital, Nov. 24) (Sir Gordon Gordon-Taylor, D. H. Patey, A. S. Till, D. W. Lacey).—Anæsthesia was administered by Dr. Sellick, first employing injection of cocaine through the thyrohyoid

membrane; intravenous pentothal; cuff tube passed into trachea perorally. Gas and oxygen; pentothal.

An inverted L-shaped incision, the horizontal limb lying above and parallel to the right clavicle, the vertical limb in the middle line over the sternum. The medial half of the right clavicle was removed subperiosteally; the manubrium sterni was split vertically, and the gladiolus sawn across between the attachments of the second and third costal cartilages. The edges of the split sternum were forcibly separated by a Tuffier retractor.

The great vessels at the thoracic inlet and root of the neck were identified, and the fistula was ascertained to be situated between the origin of the first part of the

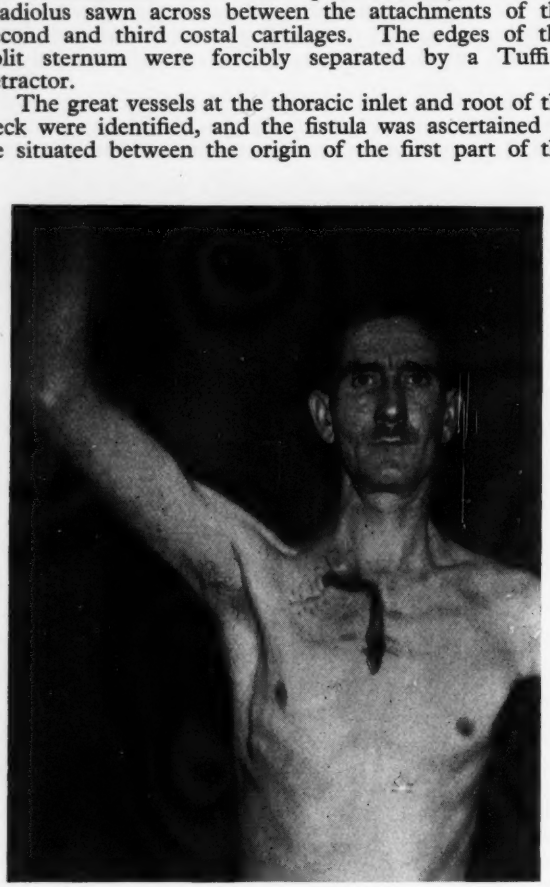

FIG. 523.—*Case* 7. The illustration shows the degree of movement at the shoulder, despite the unhealed wound and the loss of the medial half of the clavicle.

right subclavian artery and the junction of the right internal jugular and subclavian veins. The innominate artery was ligatured with tape; the right innominate vein was ligated, and the right internal jugular.

While efforts were being made to clear and ligature the right subclavian vein, which was firmly embedded in fibrous tissue and callus resulting from the previous fracture of the clavicle, the vein was torn and very severe bleeding took place. Every attempt to secure the bleeding point in the callus-impregnated tissue tore the vein wider. The hæmorrhage was finally arrested, but owing to the serious condition of the patient it was considered more prudent to return the man to bed with the artery forceps in position controlling the bleeding rather than to prolong the operation and risk further hæmorrhage from a vein or veins situated in calcified tissues which rendered ligature a matter of great difficulty and anxiety. The estimated blood-loss amounted to 5 to 7 pints, which was replaced during the progress of the operation.

The wound was loosely closed by interrupted sutures, two or three of which approximated the edges of the sternum. The artery forceps, left in situ, four or five in number, emerged from the horizontal limb of the incision.

The post-operative course was eventful. Bronchoscopy was needed on more than one occasion to aspirate considerable quantities of mucopus from the right bronchial tree. The artery forceps which had been left in situation on the bleeding area were removed five days after the operation, and the packing was also removed a day or two later.

Some infection of the wound in the neck took place, presumably along the track of the forceps, and, despite the employment of penicillin and sulpha drugs, spread to the anterior mediastinum. The edges of the incision in the sternum separated and at least provided better drainage.

The condition gradually improved and the man was able to leave Middlesex Hospital for a convalescent home. Apart from a very small sinus at the junction of the horizontal and vertical limbs of the incision the wound has healed (October, 1949). All murmurs and thrill have disappeared; movement at the shoulder is excellent (*Fig.* 523) and the man is ready to resume work.

Ligature of the Innominate Artery for Secondary Hæmorrhage.—

Case 8.—**Secondary hæmorrhage from severe gunshot wound of root of neck and shoulder region: Ligature of innominate artery. Death from sepsis from multiple wounds** (Gordon-Taylor).—

Captain Lord N. was admitted to 61 Casualty Clearing Station in the commencement of August, 1917, with multiple wounds from high explosive. The most devastating injury was a frightful wound in the clavi-scapular region, shattering the bones of the pectoral girdle and almost avulsing the upper extremity. He had lost a lot of blood and it was little short of the miraculous that he had reached the C.C.S. alive. At operation no choice was left to the surgeon save a forequarter amputation, thereby finishing the task which the shell had failed to complete.

There were no antibiotics in the First World War, and blood transfusion in the Forward Area in 1917 was not organized and was only with difficulty procurable. This officer did in fact receive a pint of blood and also saline. He made a fair recovery from his amputation and from his other less severe wounds until a secondary hæmorrhage occurred from the wound in the clavicular region. The anatomical landmarks were obscured in the septic granulations covering the wound, and while firm compression was applied to staunch the blood-loss, the sternal third of the clavicle was hurriedly removed and an adjacent portion of the sternum crudely avulsed by bone forceps, and the innominate artery exposed and ligatured.

No cerebral symptoms ensued despite the ligature of the innominate in a man who had lost a lot of blood, but the unfortunate officer died later from sepsis in connexion with this and other wounds.

Victor Bonney (1917).—

Severe secondary hæmorrhage from wound at root of neck on right side: Ligature of innominate artery. Recovery.—Soldier admitted from France to Middlesex Hospital Military Hospital, Clacton-on-Sea, in the autumn of 1917, with a high-explosive wound of the right neck just above the sternal third of the clavicle. Sudden profuse secondary hæmorrhage. The common carotid was first identified and traction was made upon it to gain access to the innominate artery; a portion of the sternum required resection. The bleeding appeared to come from the very commencement of the subclavian. Innominate ligated with silk. Recovery. The patient was sent to a convalescent hospital and about six months later was admitted to a military hospital in London. There a sinus was unfortunately explored and scraped, and the man died on the table of severe hæmorrhage.

Sir Hugh Griffiths (1917).—

Secondary hæmorrhage from the right common carotid artery following extensive gunshot wound of the neck : Ligature of innominate artery. Death ten days later.—During an air-raid on London in 1917, when at the moment the only source of lighting in a hospital ward was a hurricane lamp, a wound dressing was being performed and suddenly the common carotid artery gave way. While his assistant controlled the hæmorrhage by thumb-pressure, Griffiths in the ward made a transverse incision dividing the sternomastoid right across : the inner end of the clavicle was hastily dislocated and dragged downwards. Without retractors exposure was very inadequate, but Griffiths succeeded in passing an aneurysm-needle loaded with silk along the medial side of the bleeding vessel and in coaxing the point upwards and outwards ; a firm knot was then tied on the structure in the depths of the wound. The hæmorrhage was controlled and for some days the outlook appeared promising : there were no cerebral symptoms or changes in the upper extremity. Unfortunately he succumbed to septicæmia ten days later, and at the post-mortem the ligature was found to encircle firmly the innominate artery and right innominate vein.

Hæmorrhage from a Traumatic Aneurysm of the Second Part of Right Subclavian Artery.—

Michael Oldfield, of Leeds (1944).—

Ligature of the innominate artery. Recovery.—Milos Remetic, aged 24 years, National Liberation Army of Jugoslavia. Machine-gun bullet wound, Aug. 16 : wound of entry just below inner third of right clavicle : exit wound back of right shoulder ; also a gunshot wound of right thigh causing compound fracture of right femur in upper third. First-aid treatment only in Jugoslavia : evacuated by air to Italy and admitted to No. 64 General Hospital, Aug. 24.

An expansile pulsating swelling was noticed above the right clavicle, with a systolic bruit heard over it. Blood-pressure in the right arm 72 systolic, 60 diastolic ; left arm 125 systolic, 46 diastolic. The patient complained of very severe pain in his fingers soon after the injury, improving during the next three weeks, but subsequently the pain became progressively worse ; the pain was especially severe over the outer side of the arm, elbow, and forearm and in the radial three fingers and thumb.

On Sept. 13 the aneurysmal swelling was found to have increased in size, extending above the middle third of the right clavicle, and measuring 2 in. from side to side and 2½ in. from above downwards. Although the aneurysm mostly presented above the clavicle, a pulsating swelling could also be felt below that bone ; the edges of the swelling, which was extremely tender, were indefinite. A systolic bruit could be felt over the swelling, but no thrill was discernible ; no pulse was palpable over the brachial and radial arteries on the right side. There was an area of paræsthesia to pin-prick over the distal half of the forearm and the radial three fingers ; paralysis of the small muscles was present in the right hand.

Blood-count : R.B.C.s 3,350,000,
W.B.C.s 5,400,
Hb 57 per cent,
Hæmocrit 26 per cent.

First Operation (Sept. 14).—Under general anæsthesia the first part of the right subclavian artery was ligatured distal to the origin of the internal mammary artery, after dividing the internal jugular and vertebral veins, and after retracting the transverse cervical artery upwards ; the right stellate ganglion was removed. No radial pulse on the right side at the end of the operation, but the right hand was warm and the circulation adequate. Circulation to the hand remained satisfactory and the pain in the right hand and forearm disappeared.

Oct. 20 : Movements of the fingers, wrist, and elbow were appreciably stronger ; the radial pulse had returned ; but the swelling above the clavicle, which had disappeared after the ligature of the subclavian artery, now re-appeared and forcible pulsation could be felt and seen.

Second Operation (Oct. 24).—*Ligature of innominate artery, first part of axillary, carotid, and vertebral arteries; recovery.* (Major M. C. Oldfield and Major J. H. Mayer.)

A curved incision made over the centre of the right clavicle, extending downwards over the anterior axillary fold. Brachial plexus isolated ; right phrenic nerve retracted inwards ; anterior scalene muscle partially divided. A hæmatoma was then opened and violent hæmorrhage occurred, which was controlled by firm gauze pressure and the application of a large clamp. The clavicle was divided and the first part of the axillary artery and vein were tied. The brachial plexus was separated from the outer aspect of the aneurysmal sac and the gauze pack removed from the wound ; severe hæmorrhage started again. The inner half of the clavicle was now removed completely, and the infrahyoid muscles were divided. A finger was inserted into the chest through the pleura and hooked around the innominate artery. On releasing the thumb pressure applied over the torn aneurysmal sac the severe bleeding was now found to be under control. A ligature of stout silk was passed around the innominate artery and tied. There was still some bleeding after removing the pack, but this ceased after ligature of the right common carotid and vertebral arteries which seemed to communicate with the sac.

During the operation there had been considerable blood-loss and altogether 11 pints of blood were given during the operation and during the succeeding six hours.

The pneumothorax on the right side gradually subsided, and on Nov. 23 a radiograph showed that the lung had completely re-expanded. Circulation to the hand remained satisfactory and the patient no longer suffered pain in the hand or forearm ; the muscular power gradually returned to his right hand and forearm.

He was discharged from hospital after the wounds had healed in February, 1945, but without many of the customary formalities, after he had thrown his breakfast porridge over the Ward Sister's face (!). Later, Marshall Tito awarded him the highest military honours.

In a certain number of the cases reported in the literature the operation was not completed because of difficulties encountered or because of the sudden death of the patient during the surgical incursion. In others the operation does not come into the category of true arterial ligation on account of technical error or from the employment of some grotesque piece of surgical cutlery.

Aston Key (1844) gave up the contest after three-quarters of an hour, and W. H. Porter (*Fig.* 524) in 1831 after one and a quarter hours because of the cries and struggles of the patient ; the Dublin patient made a good recovery and, *mirabile dictu*, the tumour diminished to a quarter of the size and became firmer, and still more wonderful the patient was alive seven years later. Parham (1895) in 1894 and William Turner in 1934 failed to get a ligature around the artery ; a German surgeon, Helferich, in 1890 never found the artery ; another German, Kuhl, in 1836 mistakenly included the carotid and subclavian in his ligature instead of the innominate. Hoffman in 1839 did not like the diseased state of the arterial wall and avoided tightening the ligature ;

Hall (1833) in 1830 was found at the autopsy to have passed the ligatures through the artery and not around it. The Brazilian, Peixoto, in 1851 passed the ligature around the vessel, but did not tie it; one of Coughlin's cases (1916, reported in 1918), on whom an attempt was being made to ligate the innominate with an aluminium band, died on the table, as did that of Mont. Reid (1926) in 1918. G. H. Porter (1867) (*Fig.* 525) used an instrument like a

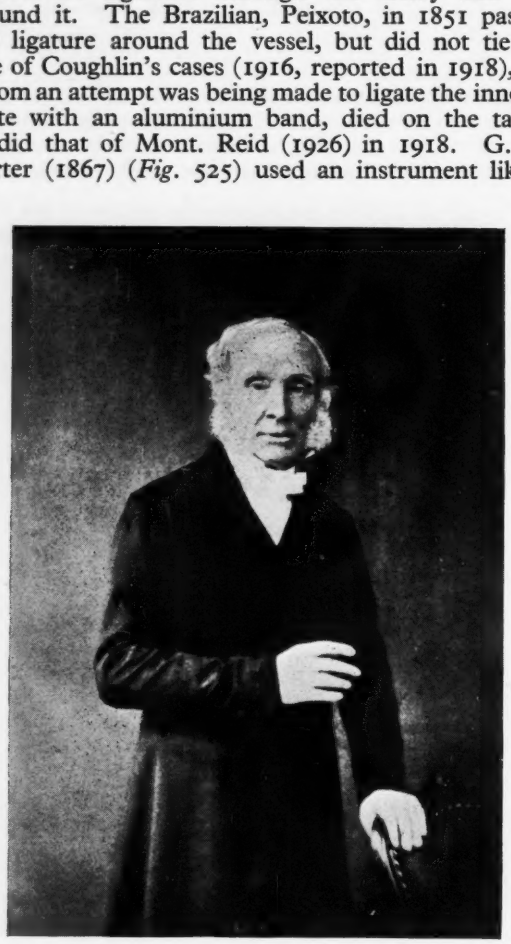

FIG. 524.—William Henry Porter, F.R.C.S., Surgeon to the Meath Hospital, Dublin, 1819–61. Compelled to abandon operation of ligature, but aneurysm underwent a spontaneous cure. Meath Hospital, 1831.

lithotrite to compress the innominate, while Annandale (1886) in 1885 used a special 'compressor': a fatal result from hæmorrhage occurred in each case.

The innominate artery has been ligatured (or attempted ligature) not less than 133 times and for various conditions. Recovery has taken place on 67 occasions (50 per cent).

The Innominate Artery has been Ligatured by:—

Surgeons of the British Commonwealth	67 times
Surgeons of the U.S.A.	44 times
Surgeons of Germany	9 times
Surgeons of Russia	7 times
Surgeons of France	3 times
Surgeons of Japan	3 times

The recovery rate in the hands of British surgeons (48·5 per cent) has differed little from that of their American colleagues (43·2 per cent). The present communication has *added 22 new cases of ligature* of the innominate artery to those already recorded in the literature, making a total of 132 cases. If from the 133 cases are subtracted the 13 cases in which the proposed ligature was not completed *secundum artem* the operation of ligature (or suture) has been performed at least 120 times.

In 1905 Sheen was able to collect 36 cases including that operated on by himself; by 1929 Greenough had collected 91 instances of innominate ligature; Lindskog in 1946 added another 18, making the total 109. Shumacker in 1947 published 1 more, while the 22 cases presented in short form in this contribution bring the present-day total to 133, as indicated above.

It will be found from a scrutiny of the cases recorded in the tables that the innominate was tied as an emergency measure for secondary hæmorrhage in connexion with a gunshot wound of the root of the neck by Victor Bonney in 1917, Gordon-Taylor in 1917, Griffiths in 1917, Harte (1897), Hutin (1842), Lewtas (1889), Lynch (1868) in 1867, and Partridge (1870). The innominate was ligatured by Coates in 1946 for secondary hæmorrhage in connexion with a series of operations for the removal of a large pulsating angioma involving shoulder, neck, and upper extremity. The artery has also been tied as a hasty emergency measure in the course of operation for

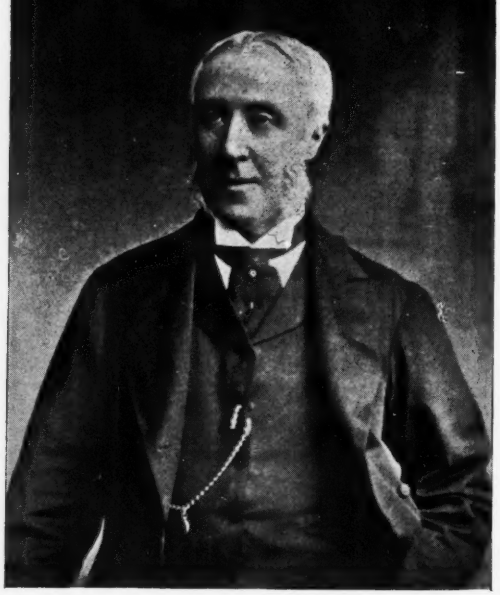

FIG. 525.—Sir George Horridge Porter, Bart., F.R.C.S., Senior Surgeon, The Meath Hospital, in 1849. Compressed innominate with instrument like a lithotrite in 1867.

aneurysm, e.g., Buchanan (1880), Chapman (1929), Holman (1927), and Oldfield in 1944.

Several cases of suture of the innominate artery have been performed for primary hæmorrhage with or without concomitant ligation of associated arteries. Sauerbruch in 1918, reported by Krampf (1926), sutured a small grenade wound of the innominate artery, the patient succumbing from suppurative mediastinitis five days later. The same surgeon in 1925 dealt successfully with hæmorrhage from a thyroidea ima arising from the innominate during the removal of a calcified tumour from the thoracic inlet; the contused wall of the innominate, including the origin of the thyroidea ima, was sutured.

The Mexican Hernandez (1900) in 1896 ligated the innominate successfully for severe primary hæmorrhage from a stab wound of the neck, while G. F. Langley in 1943, operating on an airman for a through-and-through wound of the innominate produced by a fragment of cannon-shell, performed a triple ligature, but lost his patient from cerebral anæmia.

Some reference has already been made to the *pioneer efforts of Irish surgeons*; no fewer than 10 of the cases of ligature or attempted ligature of the innominate artery have been operated upon by surgeons across the Irish sea: 6 of these patients have survived operation. Only one attempt to ligature the innominate artery had been made in the British Isles before W. H. Porter's effort (*Fig.* 524): Norman, of Bath, in 1824 unsuccessfully tied the artery on an altogether mistaken diagnosis, while the Dublin surgeon, although compelled to abandon the operation, nevertheless by his effort reduced a tumour to one-quarter the size existent before the operation, and made it firmer in consistency, while his patient was alive and well seven years after. This case was

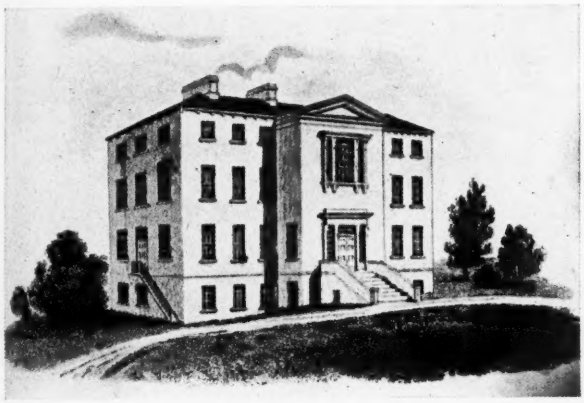

FIG. 526.—The Meath Hospital, Dublin, about the time of the Porters and others.

operated on in the Meath Hospital (*Fig.* 526), an institution famous for its surgical tradition with names like Porter (*Figs.* 524, 525) Stokes, Crampton, Singly, and Ormsby emblazoned on its escutcheon.

But 'The Mater' could also number among its surgeons Coppinger (*Fig.* 529), who secured (1893) the first real success from ligature on the Eastern shore of the North Atlantic, and also C. J. MacAuley (*Fig.* 530), who joins the ranks of those who have brought the operation to a successful conclusion.

Only one of the ten operations of innominate ligature performed by Irish surgeons was operated on by a Belfast operator, and this successful case was done on the Somme by Colonel Thomas Sinclair (*Fig.* 533) in 1916 during the First Great War.

Thanks to the great kindness of his friends, Lambert Rogers, Sam Irwin, and especially W. Doolin, the author is able to reproduce the features of the Irish surgeons whose names are associated with the history of innominate ligature.

Distal arterial ligature has been employed in certain cases of innominate (and of aortic) aneurysm. In the event of the subclavian artery alone being ligatured, the operation is termed Brasdor's, while

FIG. 527.—E. S. O'Grady, Mercers Hospital, Dublin. Unsuccessful ligature of innominate in 1873.

Wardrop's name is applied to the procedure when carotid and subclavian arteries are ligatured at the same séance. Guinard (1911) emphasized that the carotid should be tied first, because owing to suddenly changed whirls in the aneurysmal sac consequent on subclavian ligature detached clots might be carried to the brain as cerebral emboli.

FIG. 528.—William Thomson, Richmond Hospital, Dublin. Ligature of innominate in 1882.

Despite an unfavourable report by Howard Marsh in 1883 "that distal ligature may not only fail to do good, but may also do positive harm by suddenly altering the distribution of the blood-pressure, thereby throwing it on some unsound portion of the aortic arch too weak to bear it, so that an extension of the aneurysmal disease may take place in some new direction"; and despite the report of Jacobsthal (1903) that among 120 cases of innominate and aortic aneurysm treated by distal ligature only 2 lived more than three years after operation, the passage of time has not altogether endorsed these gloomy pronouncements. Long-time cures have from time to time been reported. Baldwin's (1928) patient survived a number of years; Arnold Schwyzer's (1932) rancher 22½ years; Heath's man 4 years, despite the fact that he was a drunkard.

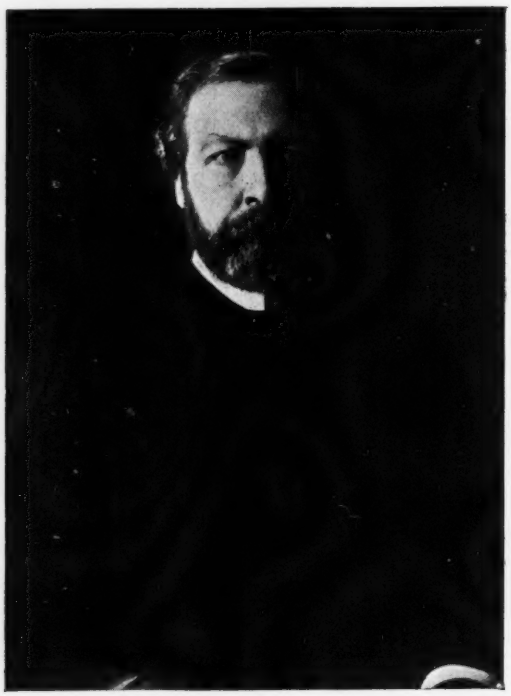

FIG. 529.—Charles Philip Coppinger, of the Mater Misericordiæ Hospital, Dublin. Successful ligature of innominate artery in 1893.

FIG. 530.—Charles J. MacAuley, Mater Misericordiæ Hospital, Dublin. Successful ligature of innominate artery in 1933.

Notwithstanding the immediate or early menace that may attend the operation of distal ligature, Matas avers that symptomatic relief may be confidently expected in nearly 25 per cent of the cases. The prognosis is better in a small or early aneurysm, and more hopeful in the saccular rather than the fusiform variety.

One of the cases quoted by Howard Marsh in adverse criticism of the procedure of distal ligature was that operated upon by Henry Lediard (1880), subsequently of Carlisle, whose patient survived nine months before succumbing to the bursting of the sac. Lediard had been a house surgeon of Syme in Edinburgh before Lister, but the operation was performed in a Sick Asylum in Cleveland Street, London, W., which is now an important annexe of the Middlesex Hospital and in which the writer himself ligatured the innominate artery in 1827 (*Case* 2). Nearly half a century before this (1880) on Good Friday, March 26, distal ligation of the carotid and third part of the subclavian was performed for what was diagnosed as an innominate aneurysm in the presence of Henry Morris* and R. Wishart Lyell of Middlesex Hospital, and Richard Barwell of Charing Cross, the last-named surgeon furnishing a flat strip of ox-aorta as a ligature. No attempt was made to divide the arterial coats. The rapidity of growth of the aneurysm was checked by the operation, and the man derived considerable relief from his symptoms.

Case 9.—**Innominate aneurysm: Ligature of carotid and subclavian. Recovery.** (Gordon-Taylor.)—

M. G., male, aged 56, with a strong history of syphilis, was seen at a hospital in the country with a large pulsating tumour filling the space above the suprasternal notch and under the inner portion of the sternomastoid. The type of tumour, the general condition of the patient, and the surgical environment negatived any thought of a proximal ligature on the innominate artery; the common carotid was ligatured above the omohyoid on July 3, 1930, and subsequently the third part of the subclavian. Fortunately the latter procedure did not prove a formidable task, and although it may not have been completed without the loss of a thimbleful of blood as obtained in Sir William Fergusson's operation in 1841, nevertheless the surgeon had no reason to be dissatisfied with his effort.

The tumour ceased to pulsate and although a firm lump could be felt in the region where the aneurysm had

* Subsequently Sir Henry Morris, Bt., President of the Royal College of Surgeons of England, 1906–8.

declared itself, this gradually got smaller as the years went past. The man survived six years, but the war years severed my contact with him and I have no knowledge as to his ultimate fate.

The writer has no experience of the Babcock operation for innominate aneurysm, although McCarthy (1930) reports that one of his patients survived more than four years, and two had been able to resume work. When one reflects upon the

FIG. 531.—Harry Meade, President, R.C.S.I., St. Vincent's Hospital, Dublin. Successful ligature of innominate in 1936.

circulatory embarrassment produced by an arteriovenous fistula, the method does not make an appeal.

I have no personal experience of the introduction of wire into an innominate aneurysm, although I have employed it several times, not without some benefit, in cases of aortic aneurysm. Scrutiny of the clinical results of wiring as well as the evidence forthcoming from museums support the practice apart from the bias furnished by tradition, for Charles Hewett Moore, who first made use of the method in 1864, was a 'Middlesex man'! Shumacker advocates its employment before distal ligation is undertaken on the ground that the formation of an intramural thrombus might prevent any catastrophic aftermath of the Brassor-Guinard operation; he would also repeat its use after distal ligation in the hope that complete consolidation of the sac might be thereby induced; George Mason, of Newcastle-on-Tyne, quite independently has also advocated this line of treatment in appropriate cases.

The contemplation of my own cases convinces me of my preternaturally good fortune in having relatively so many aneurysms arising from the distal portion of the innominate, thereby enabling a proximal ligature to be applied. As Lindskog has written: "The ideal treatment of any aneurysm, traumatic or spontaneous, is either a Matas endoaneurysmorraphy or proximal and distal ligation with excision of the sac. In the case of the innominate artery the Matas operation does not lend itself to practical application, and there is no record of its deliberate use. Complete isolation and excision of the sac have been accomplished in only 3 cases, in all of which the method was successful.

"Resort to the simpler procedure of ligation in continuity has been the rule owing to technical difficulties or to the patient's condition. Proximal ligation of the innominate, with ligation of the carotid and subclavian arteries distal to the aneurysm —the so-called 'triple operation'—has been performed more frequently than radical excision, and the *results of 'triple excision'* have been *better than those of proximal ligature alone.* Better surgical technique and more favourable operative conditions may have contributed to this difference."

I regret that my surgical attack has so often fallen short of the ideal, and that in many cases I have had perforce to content myself with proximal ligation. My own temperament does not encourage me to prolong any one surgical effort for an astronomic number of hours; and while I secretly envy the supermen and superwomen who are immune to physical and mental fatigue, the anxieties of the case and the seemingly inevitable hæmorrhages which punctuate aneurysm operations have often compelled me to "call it a day" after getting a proximal ligature around the artery, preferring to perform

FIG. 532.—Sir Thomas Myles. Ligature of innominate in 1908.

distal ligation at a later date. "A live proposition is better than a dead certainty!" The clinical result from proximal ligature may sometimes be such that further interference may not seem necessary to the surgeon or may be refused by a satisfied patient.

My personal experience of injury or disease of the innominate artery does not end with the cases

already recorded in this communication for which some form of surgical operation or other treatment has been possible :—

Case 10.—**Severe wound of innominate artery: Primary hæmorrhage. Immediate death.**

I had the misfortune to be very close at hand to an Army Nursing Sister in a Casualty Clearing Station (44 C.C.S.) in the Ypres Salient during the autumn of 1917, who received a frightful through-and-through wound of the right sternoclavicular region from a shell

FIG. 533.—Colonel Thos. Sinclair, C.B., of Belfast. Successfully ligatured innominate in France in 1916. (*Photograph taken before outbreak of* 1914–18 *War.*)

fragment from a high-velocity gun, and who succumbed in a few seconds, the innominate artery having been torn off the aorta.

SUMMARY

1. Seven personal cases of ligature of the innominate artery are briefly presented.

2. Two additional personal cases of aneurysm of the innominate artery are described, where treatment has been by medical measures or by distal ligation.

3. There is presented in chronological order a list of the surgeons who are known to have ligatured the innominate artery from 1818 to 1949.

4. The innominate artery has been ligated more frequently by the surgeons of the British Empire than by those of any other nation.

5. The share taken by the surgeons of Ireland in promoting the operation is described and photographs of all the Irish operators are included.

6. The contrast in the mortality from the operation until the time of William Sheen (1905) and that obtaining in the past quarter of a century (1924–49) is noted.

7. Twenty-two unpublished cases of ligature of the innominate artery are reported and added to the literature.

8. The surgeons of Middlesex Hospital, London, have ligatured the innominate artery on 12 occasions.

9. Sir Charles Ballance (St. Thomas's) ligatured the innominate 5 times; Matas (New Orleans), Holmes Sellors (Middlesex Hospital), and A. E. Coates (Royal Melbourne Hospital) each 4 times; the writer 7 times.

10. Despite certain gloomy pronouncements on the end-results of operations for innominate aneurysm and aneurysm at the root of the neck, a number of patients are to be found in the tables who survived many years after operation.

My burden of indebtedness to others in the preparation of this lecture is a heavy one, but my foremost duty is to thank the Council of the Medical School of the University of Cardiff for the honour of this invitation. My friend and old pupil and shipmate, Surgeon-Captain Lambert Rogers, V.R.D., has once more placed me under a deep obligation; his own historical bias has influenced me in endeavouring to trace once again the story of the surgery of the innominate artery.

The labour so ungrudgingly given me by my learned friend, William Doolin, Litt.D., F.R.C.S.I., to aid me in making up my Irish surgical "portrait

FIG. 534.—Sir William Wheeler, Dublin and London. Successful ligature of innominate in 1932.

gallery" deserves my special acknowledgement: to him I have never turned in vain and he has always produced a material response to my urgent messages across the Irish Sea.

Finally there are all the surgeons of the British Commonwealth who have answered my inquiries and unhesitatingly placed their material at my

disposal; to this band of brothers my gratitude is sincere.

The illustrations which are to be found on the pages of this communication are from the pencil and brush of Miss Gwen Trew; the photographs were prepared by my friend, Mr. Edward Bridger, of Middlesex Hospital, and by Mr. Maurice Turney. These may serve as a pleasurable distraction for the hardy reader who ventures to embark on the perusal of this offspring of the acquisitiveness of a *ramasseur*. To all I labour under a deep debt of obligation. My most grateful thanks are also due to Miss Patricia Edwards, Secretary to the Professor of the Surgical Unit, Middlesex Hospital, who has had the misfortune to undertake the responsibility of preparing the typescript.

I never knew Sheen well; I have not the privilege of membership of the Moynihan Club, that very select group of hospital surgeons of provincial universities, membership of which carries a certain *cachet* and to which the ambitious must aspire. But diligent reading of the man and his work, and conversations with those who knew him, recall to my memory the tribute of John Buchan, first Lord Tweedsmuir, to that fine Scottish nobleman the great Montrose, whose mutilated remains now lie in belated honour in the Cathedral of St. Giles up there on the approaches to the old Castle Rock which guards the Scottish Capital: his words seem not inappropriate to the one whom we commemorate tonight: "He is a figure who must always inspire those who travel the rough roads of history . . . his course set unfalteringly towards his dreams, carrying an awful warmth about his heart like a load of immortality. . . . His qualities in the retrospect seem to be drawn to a fine edge of burning light; but as we wonder and revere, there comes a voice from behind the flame, and awe is changed to wistfulness; for it is a voice of comradeship and joy and youth." Such a one was the first Provost of your Medical Faculty, such a one was your famous surgeon, "resolved to fight on with honour and fidelity to the grave"; such was William Sheen, in whose treasured memory this address has been delivered this November night. It has been an added privilege that this William Sheen Memorial Lecture should have been heard by some who were his colleagues, pupils, and friends.

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PHARYNGEAL DIVERTICULUM

BY SIR THOMAS DUNHILL

ON a subject where the problem remains the same, but where practice differs in so many respects, it has long seemed to me that surgeons who have dealt with a number of cases should add their contribution to the published records. I was diffident about doing so because a good deal has been written on this subject and a further article might seem to be redundant, but when in 1948 a patient sought advice about a diverticulum which had been operated upon in 1947, and who was left more uncomfortable than before the operation, publication of one's experiences seemed to be justified. In this case a surgeon on the staff of a teaching hospital had performed the operation described by Hill in 1926. Following this the pouch hung in a festoon and could not be emptied (*Fig.* 535).

Again, for the following reasons, the current view of the aetiology does not seem satisfactory: (1) Following radical operation the condition is cured without recurrence while the alleged causes still remain; (2) A diverticulum sometimes occurs in several members of one family; (3) It may be found in routine examination, the patient being unconscious of any disability due to its presence. These points will be discussed in more detail later.

An operation designed to give relief from a severe disability may itself carry grave risks. A pharyngeal diverticulum is such a disability, and it is one which inevitably—though perhaps slowly—progresses. The risks of operation are due partly to its situation, for when of moderate size it overhangs the mediastinum and when large it enters it, and partly to the fact that it is not covered by a serous membrane. Cure can only be attained by excision of the diverticulum. By trial and failure, and ultimately by trial and success, surgeons have succeeded in avoiding leakage with its consequent mediastinitis.

This article is based on the records of 28 patients—19 male and 9 female. Of these the youngest was aged two, and the oldest—a very recent case—ninety-two. Twenty-one have been operated upon; of these 14 were over sixty years of age and 5 were over seventy—the oldest seventy-seven. With the exception of one patient in whose pouch extensive carcinomatous growth had taken place which ultimately prevented swallowing, there has been no death following operation. In this patient the growth filled the pouch, fungating through its neck into the pharynx, and the fundus of the pouch was adherent to the aortic arch (*Fig.* 536).

In the British Empire it is the custom for surgeons to work as individuals: we have not the large clinics which are a feature of surgical practice in the United States, and therefore the number of cases of this comparatively rare condition seen by a British surgeon does not reach that of American surgeons. Nevertheless, if the cases operated upon

by the late W. H. Kelson and Wilfred Trotter, by John Morley, Julian Taylor, myself, and others are added together they make a goodly showing.

My first patient was operated upon in 1923. This paper was prepared in its original form and delivered to the Surgical Professorial Unit of St. Bartholomew's Hospital in 1934 with notes of 6 cases. In the first 3 of these a two-stage operation

FIG. 535.—A diverticulum subsequent to operation for diverticulopexy. The type of operation should not be blamed for this result.

was performed, which most surgeons at that time regarded as the only safe method—Kelson's 2 cases in 1913 and 1914 seem to have been forgotten (Kelson, 1919). For reasons which will be given later a one-stage operation was performed on the other 3 patients. Also in the 3 later cases I employed an incision of the collar type. The methods which I had evolved then have been followed since. Cases operated upon during the fifteen intervening years have confirmed the safety of that technique. Naturally other surgeons were thinking along similar lines, and naturally not all surgeons agree in the details.

ANATOMY

A pharyngeal diverticulum is a herniation of the mucous membrane through the wall of the pharynx, occurring in the great majority of cases through an area situated more or less posteriorly at the junction of the oblique and circular fibres of the inferior constrictor muscle.

Although this article is primarily concerned with the radical operation for diverticula, surgeons are always curious regarding any deviation from the normal with which they are called upon to deal. Indeed, it is noteworthy that, in this century, dissections for this purpose have been either carried out or instigated by surgeons — Killian (1908), Waggett and Davis (1912), Moynihan and Jamieson (Moynihan, 1927).

Shallow, who in an article in 1948 records 186 operations, in stating that Killian's work published in 1908 was epoch-making, writes that much of Killian's labour went for nought until Sir Berkeley Moynihan in association with J. K. Jamieson investigated this area in 1927, confirmed Killian's findings, and emphasized their importance. As the result of Killian's work it became established that the greater number of diverticula originated between the oblique and the transverse fibres of the inferior constrictor muscle—the transverse fibres being named the cricopharyngeus muscle. Killian named this the 'sling muscle' because in swallowing it shuts off the pharynx from the œsophagus until sufficient pressure becomes established in the pharnyx to shoot the bolus into the œsophagus.

Two points are still under discussion: (1) Both Killian and Jamieson noted an area below the cricopharyngeus between that muscle and the upper fibres of the œsophagus—a slit embedded in fatty tissue—situated on the posterolateral aspect on either side which gives passage to a branch of the recurrent laryngeal nerve, a branch of the inferior thyroid artery, some veins and lymphatics. Moynihan had found two cases of lateral diverticulum reported in the literature, both carefully dissected, one by Butlin in 1893, and one by Chevalier Jackson in 1926; the former is in the museum of St. Thomas's Hospital. He believed that these lateral diverticula originated *below* the cricopharyngeus through

FIG. 536.—Lateral view of a pharyngeal diverticulum invaded by carcinoma.

this lateral slit. The writer of the present article is of the opinion that the diverticulum illustrated in *Fig.* 540, which is seen to be situated anteriorly, is of the same nature, i.e., arising laterally and tilted forward. More detailed observation of this case cannot yet be given. Shallow believes from observations made at operation that 2 of his 186 cases originated through this slit. (2) Regarding the second point, Shallow believes that, of the diverticula arising between the oblique fibres of the inferior constrictor and the cricopharyngeus, most originate not in the midline but posterolaterally. He bases his belief on the evidence gained from dissection of the neck of the pouch. His œsophagoscopist agrees to only 40 per cent of them having a posterolateral origin, but even this is a considerable number. Respect must be paid to the opinion of a surgeon who has operated upon such a large number and whose attention has been drawn to and then focused on this point. The most that one would be prepared to say is that surgeons in this country find diverticula readily approachable from the left side, and also that the distal aspect of the neck of the sac is singularly accessible if in fact the herniation

originated in the midline. It would be tedious in this paper to argue further a matter which is, to some extent, of academic interest. With the greater number of cases now coming for radical operation, and with the points under discussion kept in view, surgeons, œsophagoscopists, and anatomists will gain accurate knowledge. I place the groups of investigators in this order because, fortunately, surgeons and œsophagoscopists now see far more cases than morbid anatomists. Exact observation

FIG. 537.—Photograph of a diverticulum excised by Kelson in 1913. The opening into the pharynx was closed by immediate suture. The two layers which constitute the wall are well shown.

during the dissection by surgeons, and examination by endoscopists cause no delay or added risk to the patient. On the contrary, careful dissection right up to the junction of the neck of the sac with the pharynx is essential to avoid injury to the recurrent laryngeal nerve, as well as to close the opening into the pharynx efficiently. The articles by Killian, Shallow, and Moynihan repay careful study. The last word on the origin of pharyngeal diverticula has not yet been written.

The wall of a diverticulum consists of two distinct layers, each strong and manageable, loosely connected by areolar tissue and readily separable. The outer layer is formed by fibrous tissue around the fundus, but at—and in the neighbourhood of—the neck of the pouch it contains a good deal of muscular tissue which is continuous with the musculature of the pharynx. The inner layer consists of mucous membrane (*Fig.* 537). These two layers form the basis of the two-stage operation as performed by Wilkie and Hartley (1922), Lahey (1923), and others; and, as each of the two layers holds stitches securely, they make possible the one-stage technique described later in this article.

AETIOLOGY

The formation of a diverticulum has been considered to be due primarily to disordered physiology, the sequence being that food after mastication is normally held in the pharynx by closure of the cricopharyngeal sphincter until sufficient rise of pressure in the pharynx is obtained by the action of the mylohyoid, hyoglossus, and the oblique fibres of the constrictor muscles to overcome the compression and shoot the bolus of food into the œsophagus as the cricopharyngeus relaxes to allow it to pass. These movements of closure, pressure, and relaxation are dependent on neuromuscular co-ordination, and it is suggested that if this co-ordination fails, relaxation of the cricopharyngeal sphincter is not complete or adequate. Some important facts are difficult to explain if this view is accepted. According to it, formation of the diverticulum should be associated with some degree of dysphagia. The diverticulum shown in *Fig.* 538 was found in 1945 during the routine examination of a patient aged 67. Although it is not big, it probably took some years to reach the size shown. The patient had never experienced any difficulty in swallowing and now, four years subsequently, is still completely unaware of its presence. Another point: if diverticula arise as a result of neuromuscular inco-ordination associated with loss of tone in the musculature, it seems strange that simple removal of the pouch and suturing of structures in an elderly individual, whose musculature has become poor and

FIG. 538.—A diverticulum without symptoms, found during a routine examination of the stomach. As there were reasons for not drawing the patient's attention to the condition a special film of it was not taken.

stretched, should cure the condition and give freedom from recurrence while the causes which originally induced it remain. Neuromuscular inco-ordination is not removed by operation, nor should operation prevent spasm of the cricopharyngeus, nor does it restore to the pharynx its youthful tone and elasticity. If factors to which it is usually ascribed were all-important, recurrence should not be infrequent, whereas recurrence does not occur when the diverticulum has been efficiently removed; nor, in this series, has dilatation of the cricopharyngeus subsequent to operation ever been necessary. Certainly swallowing is conditioned by pressure in the pharynx, but it is a fact that patients in the sixties and seventies have swallowed with complete comfort after operation into extreme old age.

From time to time the question has been raised whether a congenital factor may influence formation seeing that the situation is remarkably constant and the pouch, if old-standing, acquires such length relative to the calibre of its opening into the pharynx (*Fig.* 539). In length it not infrequently reaches the arch of the aorta, while the diameter of its neck remains comparatively narrow, rarely more than 1·5 cm.

FIG. 539.—Showing the length and size of the diverticulum compared with the narrow opening into the pharynx.

Regarding the question of a congenital factor, the history of two families is significant: In 1932 I had operated—with Mr. Capps—upon a patient of Dr. Barnes of Woburn with carcinomatous change in a very large pharyngeal pouch. Dr. Barnes has since informed me that a brother of this man has been operated upon for a pharyngeal diverticulum by Mr. (now Sir) Heneage Ogilvie in the local hospital; that their father and grandfather both died from a similar condition, and that two other relatives suffered from a pharyngeal diverticulum. This is a remarkable story. Regarding the second family, my friend Dr. Dinsmore (1942) has reported that he had operated upon two brothers for a similar condition.

Another notable point when considering the possibility of a congenital factor is the occurrence of a diverticulum discovered in a child aged 2 years. Through the courtesy of Dr. W. G. Wyllie and Dr. L. G. Blair I have notes and a radiograph of this patient (*Fig.* 540). Wilkie and Hartley (1922) wrote that no case had been reported in infancy or childhood and this is the usual experience. It will be noted that the radiograph shows this pouch arising apparently from the anterior aspect. This may originate through the slit giving passage to vessels and nerves, described by Killian and by Moynihan, at the junction of the pharynx with the œsophagus, more anteriorly than usual. This film was taken four years ago. The child's mother is not willing for another X-ray, or for endoscopic examination to be made yet, as she considers the child is progressing reasonably well. It will be interesting to see the situation of the opening of the pouch when

FIG. 540.—Diverticulum in a child of 2 years. It is situated anterior to the œsophagus and posterior to the trachea.

endoscopic examination is permitted. The occurrence of six pouches in one family tree and of two in another, the presence of a pouch in a young child, and of one for at least four years in an elderly patient without symptoms, together with the difficulty of making neuromuscular inco-ordination fit in with the fact of complete cure following excision of the pouch, prevent us from dismissing a congenital factor too summarily. There are similarities between diverticula of the pharynx and those found in the cardiac end of the stomach and in the duodenum.

SYMPTOMS AND PROGNOSIS

Symptoms may be absent, they may be comparatively mild, or they may be most distressing. *Fig.* 538 is an instance of the presence of a diverticulum without symptoms. Dr. Blair and I were examining a patient who had been sent to me at the E.M.S. Hospital, Harefield, Middlesex, in 1945, suffering from a diaphragmatic hernia with a chronic ulcer in the thoracic loculus of the stomach when a pharyngeal diverticulum was discovered of which the patient was completely unaware. She had never suffered from dysphagia. This patient has been under observation for four years since and she still takes food naturally and is unconscious

of any difficulty in swallowing. One wonders how long this pouch has been present. It should take a considerable time to reach its present size. If a pouch can occur without symptoms in one patient it may do so in others, but it would make it difficult to accept dysphagia as a cause.* I have no personal evidence of troublesome symptoms associated with a small pouch.

When patients have come with the characteristic symptoms the diverticulum has been found well developed. As it increases, the fundus, distended with its contents and lying between the unyielding spine and the œsophagus, pushes the latter out of line with the pharynx and increases the difficulty of food entering. The patient now becomes miserable. Added to unsatisfied hunger is the unpleasantness of regurgitation of food. One patient kept a chamber beside him which he filled with ejected food and mucus twice a day. Gurgling noises on swallowing are heard by many patients, due to air being mixed with pouch contents, and these sounds are often audible to others. Sufficient food may be ingested to prevent loss of weight for years, but ultimately the patient is not adequately nourished. Two of my patients had lost over 4 st. in weight. The ' spill-over ' from the diverticulum may enter the glottis, causing irritation. The resulting cough may be paroxysmal and is sometimes associated with rise of temperature. This laryngeal irritation varies curiously with different patients. Two have volunteered the statement that if they lie in a certain position they can empty the pouch before going to bed and then sleep comfortably; if they fail to do so their cough is uncontrollable until they do. These two patients have no cough when in the erect position. Others suffer from attacks of coughing while upright, but their sleep is undisturbed —probably because the pouch empties in the recumbent position. Most patients nowadays come for operation when symptoms become distressing; if they do not, the pouch becomes a menace. To my knowledge two patients have died from septic pneumonia following inhalation of pouch contents. Whilst awake and conscious the larynx and trachea may be cleared by coughing, but a patient is not always awake and conscious. One of these two had celebrated not wisely but too well and in this condition was unable to prevent entry of contents into his bronchial tree. The second patient had undergone an operation for another condition, and while unconscious the contents of the pouch entered the larynx and trachea. In each case death from pneumonia followed. If carcinomatous change occurs, blood may be present in the expectoration.

DIAGNOSIS

When dysphagia occurs there should be no delay in making an X-ray examination, whether this be due to cardiospasm, carcinoma of the œsophagus, diverticulum of the pharynx, the Plummer-Vinson syndrome, or any other condition. The X-ray picture of the pouch is characteristic, with its rounded fundus, the relatively narrow neck, and the ' spill-over ' of barium into the œsophagus. It will demonstrate the smooth contour of an uncomplicated pouch, or any irregularity suggesting a filling defect caused by carcinoma (*see Fig.* 536). Some may feel that they would like œsophagoscopic confirmation. This is essential if there is any doubt of malignant change, either because of blood-stained expectoration or irregularity of contour in the radiograph. Rarely the fundus of the pouch may appear divided, giving the appearance of a double pouch. Shallow (1948) and Graham (1942) have each reported a case. The former stated that in his patient the appearance was caused by the pouch straddling a pharyngeal branch of the inferior thyroid artery.

LITERATURE

The literature is extensive and accessible. We are only concerned with the relevant stages which lead up to present practices. Zenker in 1876 had recognized that removal of the sac would cure the disability, but at that period of surgery he also realized that removal of the sac was a vain wish. It was attempted by Niehans in 1884, but the patient died. It was successfully carried out by Wheeler of Dublin in 1886. Judd credits Von Bergmann with the first successful case in 1892, but that was six years after Wheeler's case. Notwithstanding the successes of Wheeler and of Von Bergmann the death-rate for the operation for excision of diverticulum remained high. Patients who survived the operation were cured, but because of the death-rate surgeons sought a method of giving relief by some means short of opening the mucous membrane. William Hill (1926), of St. Mary's Hospital, practised successfully a palliative operation of merit at that time, by which the pouch was dissected up to its junction with the pharynx and the fundus fixed at a higher level by sutures so that the opening was directed downwards. Hill gave the name ' diverticulopexy ' to his operation. This method was followed by Waring and Douglas Harmer, and is still performed by Graham (1942) and other surgeons for large pouches, or for pouches occurring in the elderly. Some patients with a diverticulopexy have subsequently swallowed for years and ultimately died from other causes. Notwithstanding this, it is not an ideal procedure. It has served its purpose in the evolution of treatment. Hill himself wrote that the tendency of most ' pexies ' is to recur; carcinoma has occurred in at least two patients who had undergone this palliative operation; as stated in the opening paragraph of this article, a recent case obtained no relief, but the chief point is that, even to give temporary relief, there are better methods.

Because of the possibility of recurrence surgeons had been giving thought to making safe a radical operation which would remove the sac and leave a normal pharynx, while reducing risk to the minimum. Goldmann reported two successful results in 1908 in each of which the operation was carried out in two stages. At the first operation Goldmann withdrew the fundus of the diverticulum through the operation field to the exterior and sutured it to the

* It will be noted that the diverticulum is not near the centre of the film. The patient was very ill with the condition for which she was admitted. She was intensely opposed to further X-ray examination and it was thought inadvisable at that time to draw her attention to still another pathological condition.

skin (*Fig.* 541). He performed the second stage ten days after the first, believing that the tissue planes and lymphatics leading to the mediastinum would have become sealed off by that time. He therefore considered it safe to re-open the wound, resect the pouch at its neck, and suture the opening into the pharynx, much as one now does in a single-stage operation. Following this practice in my first three cases I found the tissue planes leading to the mediastinum were not sealed off. When the incision was re-opened and the structures retracted to reach the neck of the sac the space between the pharynx and the prevertebral muscles leading to

FIG. 541.—The first stage of the operation as performed by Goldmann, Wilkie and Hartley, Lahey, and others.

the mediastinum was seen to open widely; and furthermore, completing the operation was a messy job when carried out in the depths of an operation field made ten days earlier. Nevertheless no mediastinal infection followed. Goldmann himself must have had the same experience with his earlier two-stage operation—i.e., seeing the plane between the prevertebral muscles and the pharynx leading to the mediastinum open widely when the sides of the operation field were retracted—because he sought a modification of it. Goldmann's later methods have not held a place in surgery. Wilkie and Hartley published a better method in 1922. Probably Sir Harold Stiles helped to originate this method, for the first of the two cases published by them was operated upon by Stiles in 1920 and the second by Wilkie in 1921. In their method the fixation of the pouch by suture to the skin at a high level was carried out according to Goldmann's original methods; the second stage differed—and this was a notable advance—in that the incision was not re-opened to reach the neck of the pouch. The fundus was cut off level with the skin. They realized that the mucous membrane could be readily stripped from, and closed within, the tunnel of the fascia propria. Thus there was no possibility of infecting the deep planes of the neck. Meanwhile other surgeons had been giving thought to the problem and surgical technique was improving. As early as 1913 Kelson in London had operated upon a patient successfully by a one-stage method and upon a second patient in 1914 (Kelson, 1919). He demonstrated that a one-stage operation could be performed without any complications. Wilfred Trotter always performed a one-stage operation, as does Morley of Manchester (1945). In America Shallow always does so and Stuart Harrington (1939) employs it to an increasing extent, but Frank Lahey (1937) has for years thrown his great prestige in favour of the two-stage method.

DISCUSSION

Reading the accounts of cases published in recent years and articles on the subject in most modern text-books, it would seem that there is reason for further discussion on (1) aetiology, (2) the incision, (3) the method of extirpation of the pouch, and (4) drainage.

1. *Aetiology.*—This has already been discussed (*see* p. 406).

2. *The Incision.*—During the period when I was engaged upon my earlier cases I was frequently operating upon goitres, some of which were of considerable size. It is common knowledge that in some of these the lower pole enters the thorax, while the upper pole extends high in the neck. Many opportunities therefore occurred of examining the upper part of the œsophagus and the constrictor region of the pharynx. It was obvious that the area brought under vision in operating upon such cases was as extensive as was required in a vertical direction, and far more extensive laterally than with a vertical incision. In the fourth case therefore—in 1931—a collar incision was made, mainly left-sided, situated about an inch above the clavicle. Two advantages were at once manifest over the vertical incision then universally employed: the sternomastoid muscle was retracted laterally more easily and without strain—there was no need to incise its anterior border as was thought necessary by some surgeons, nor was there any need to divide the infrahyoid muscles; secondly, the larynx, trachea, pharynx and upper part of the œsophagus rotate more easily on a longitudinal axis so that the distal aspect—the right side—of the neck of the diverticulum becomes readily accessible. A colour-film which has been made shows how completely adequate access is. Every detail of the operation is as unhampered as though it were carried out at surface level. Dinsmore and John Morley have each adopted this incision. Against this Frank Lahey, Stuart Harrington, Shallow, and Graham still employ an incision along the anterior border of the sternomastoid muscle. *Fig.* 542 shows the inconspicuous scar which results from a collar incision. It is less visible than the two natural creases in the skin above it. For this operation the appearance of the healed incision, no less than the cure of the disability, is important for patients and should surely be the hall-mark of the surgeon.

3. *Method of Extirpation of the Pouch.*—Regarding the one-stage or two-stage operation, as becomes

any surgeon undertaking an operation for the first time which he may be performing only occasionally, this. In 1917 in France during the first world war a soldier had swallowed his upper denture. Some

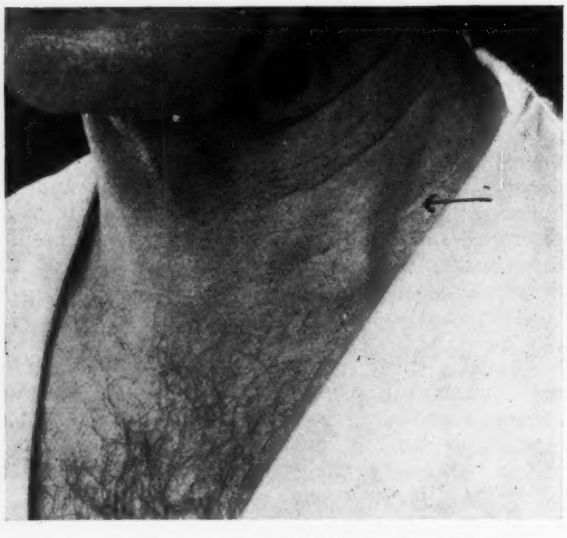


FIG. 542.—The scar of the incision ten days after operation is less conspicuous than the two natural creases in the skin above it.

FIG. 543.—A denture in the œsophagus.

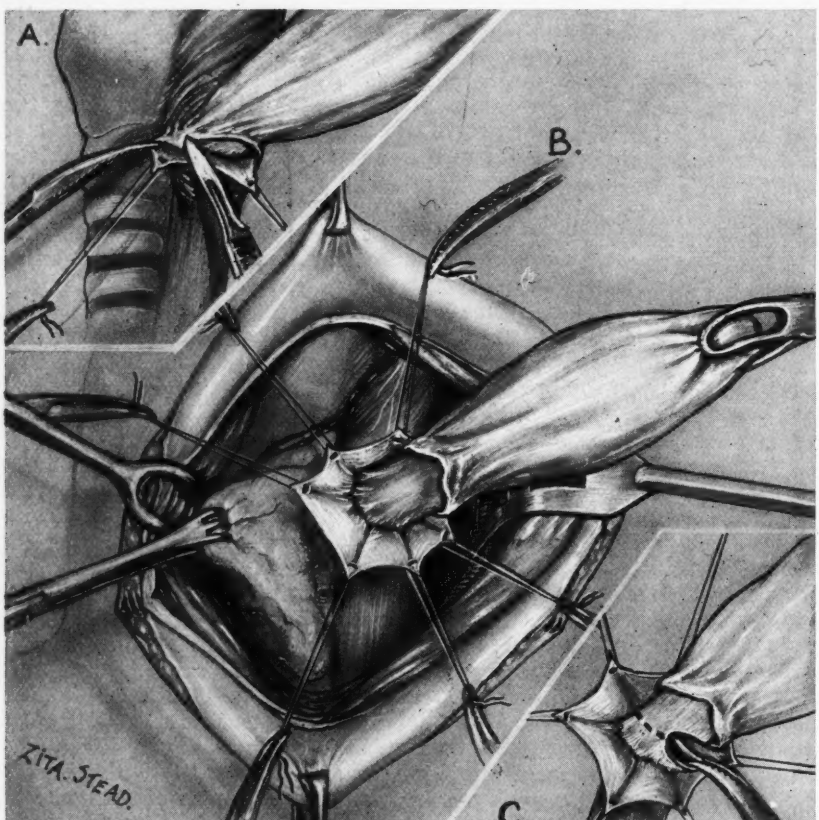


FIG. 544.—A, The outer layer of the sac is being incised to prepare the cuff. B, The cuff prepared and held by stay sutures. C, The mucous-membrane layer is incised and its margin held by curved hæmostats.

days passed before he came under my care. X-ray examination showed the denture fixed in the œsophagus at the level of the root of the neck (*Fig.* 543). At that date œsophagoscopy was not practised regularly as it is now, and therefore I removed the denture through an incision in the neck. This necessitated an adequate opening into the œsophagus, cutting the denture in half in situ, and removing it in two pieces. It is unlikely that the denture was sterile. The opening in the œsophagus was closed, the dissection in the neck smeared lightly with B.I.P.P., and sutured around drainage tubing. Healing was uneventful. Pondering over this I thought that a washed-out diverticulum was less likely to infect surrounding tissues than an unclean denture. Furthermore I had had occasion to open the œsophagus for other conditions and had become familiar with the access to, and the anatomical relations of, diverticula through operating upon the earlier cases, as well as being accustomed to neck surgery for other pathological conditions, so that there seemed no valid reason against completing the operation for pharyngeal diverticulum in one stage. This was done. The operation went smoothly; healing and convalescence were uneventful. The one-stage procedure has been

I followed tradition by employing a two-stage procedure in 1923. In 1930 I recalled some of my own experiences which made me doubt the necessity for

followed since. I wrote to Wilfred Trotter in 1937 to try to persuade him to publish something on this subject, for I knew that he had performed the operation many times, employing a one-stage method. An extract from his reply was as follows: "I have never done anything but the single-stage operation for pharyngeal pouches, and have never lost a case from leakage or sepsis. It would be difficult to say how many cases this includes and would involve a long search, but the number must be substantial. I am so glad that you are publishing something about them."

Surgeons who perform the one-stage operation differ a little in the method of closing the neck of the pouch. Morley employs a clamp and closes the neck of the sac in the manner described by Moynihan for closing the duodenum after its division in the operation for partial gastrectomy. I have a stomach tube passed by the anæsthetist as soon as the diverticulum is lifted from its bed. This tube is easily guided by the surgeon into the œsophagus at this stage. A cuff of fascia propria (*Fig.* 544) is then prepared by incising it without opening the mucous membrane about 1·25 cm. from the junction of the pouch with the pharynx. Being close to the pharynx this cuff contains muscle-fibres and forms a strong layer. Its margin is picked up by a series of stay sutures which hold it until required. The mucous-membrane layer strips easily and neatly from this cuff; the mucous-membrane layer is now opened and the diverticulum amputated, its margins being picked up by very light curved hæmostats. The stomach tube is seen lying in the pharynx and disappearing into the œsophagus. The junction of the mucous membrane of the pouch with that of the pharynx is clearly seen, and this layer is closed by a continuous suture (*Fig.* 545). This line is then covered by suturing the first layer—the cuff of fascia propria which has been prepared for the purpose—over it. These differences in the method of closure are probably of little moment, but naturally we each prefer the technique to which we are accustomed. The method I have described has given complete freedom from complications.

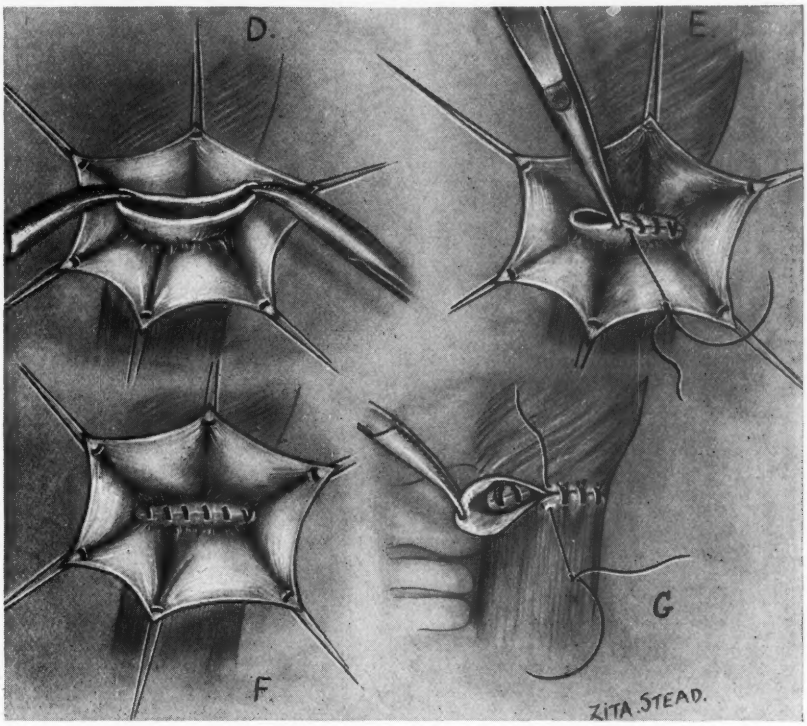


FIG. 545.—D, The diverticulum has been removed; the cuff is held by stay sutures, the mucous-membrane layer by hæmostats. E, The mucous-membrane layer is being closed by a continuous suture, shown completed in F. G, The cuff is closed over the deeper layer by interrupted sutures.

Regarding the complications which may follow the one-stage and the two-stage operations: Lahey has described with commendable honesty the complications which have followed the two-stage operation, and I do not wish to magnify them. They have not proved serious, but they have not been infrequent. The œsophagus has been drawn out of alinement by traction when the sac is withdrawn and sutured to the skin at the first stage, so that swallowing was prevented until this tension was released; one sac became necrotic, and, even when everything has gone smoothly a fistula has sometimes remained for a not inconsiderable period. These are not negligible complications. Subsequent to the two-stage operation Lahey practises dilatations with bougies. This I have never found necessary, and the physicians from whom the patients have come tell me that swallowing has remained normal. There is another reason against the performance of the two-stage operation by competent surgeons. Those who do so give as their reason the great danger of mediastinitis. This danger has been exaggerated and publicized to such an extent that physicians have felt compelled to emphasize the danger of operation to their patients so that some have been dissuaded from operation. This has led to much suffering and some deaths.

4. *Drainage.*—This has been gradually simplified as the use of extensive drainage has proved to be unnecessary. Careful hæmostasis and suturing of the neck of the pouch in two layers has given absolute security. There is very little discharge and what there is is serous. That there is any at all may carry the implication that a possibility of spreading infection exists. Possibly it does; practically this has never occurred in my cases, nor to Shallow with his large series of cases. At my first one-stage operation I adopted the drainage plan that I had learned from French surgeons for war wounds during the first world war—drainage filiforme. They found, as we all have, that the outside circumference of a tube often becomes glued to the skin, and its lumen choked with coagulum and thus it fails to function. They conceived the idea of using very

fine strands of rubber, solid and square on cross-section. A small bundle of these was inserted into the depths of a wound. One rubber strand could be withdrawn daily if necessary ensuring an unchoked passage to the exterior. I now use two very thin tubes of small calibre together with a narrow strand of corrugated rubber. One of these is withdrawn next day and the others very soon. With so many

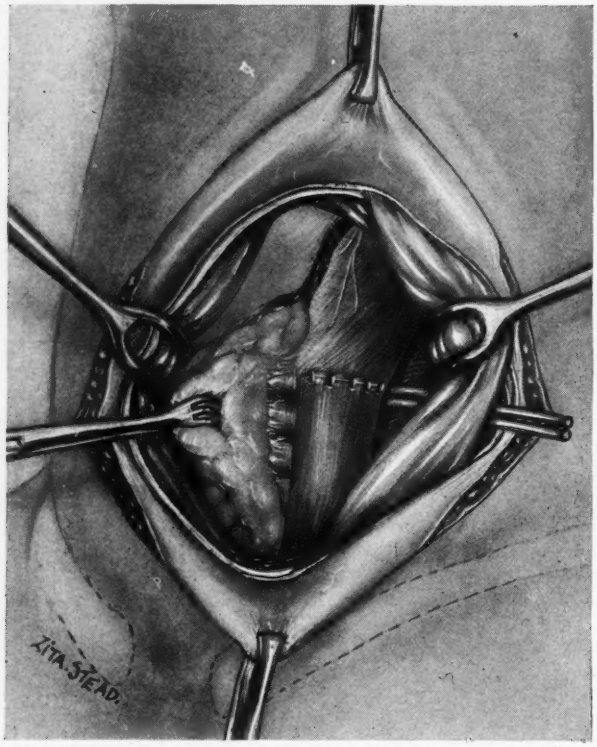


FIG. 546.—The drainage tubes placed behind the suture line brought to the surface above the carotid sheath, deep to the sternomastoid muscle, reaching the surface at the lateral end of the incision. Along this track they lie naturally without bending or causing pressure.

others, I had always admired the work of the late Rutherford Morison, and in war wounds in France had used his method of cleaning the area and lightly smearing it with B.I.P.P. I adopted both the B.I.P.P. procedure and the filiforme method of drainage for my earlier operations. In those cases the anterior half of the sternomastoid muscle was divided and the drainage rubber brought to the surface through it, but there was so little discharge, and that little consisted solely of serum mixed with B.I.P.P., and furthermore the direct way to the surface seemed to lead *lateral* to the sternomastoid muscle, so for a long time now drainage has been led from the sutured pharynx deep to the sternomastoid to reach the surface at the lateral end of the skin incision (*Fig.* 546). I may be asked, why use B.I.P.P.? Well, it is of a greasy consistence, it prevents the wound glueing up, and it does not delay healing; I have felt happy with it and I suppose that I have been as reluctant to give it up as some of my friends are to give up diverticulopexy and others to give up a two-stage operation or a vertical incision—we are each prone to remain at the stage which has given us satisfaction. However, with increasing confidence and the absence of complications, I have now ceased to use B.I.P.P. Sulphonamide and penicillin have been used recently, but as there never were any complications before these were employed, I cannot ascribe an uneventful convalescence to them. Careful surgery—which includes careful dissection, complete hæmostasis, and accurate suturing — remains the important factor.

I have outlined my practice as regards incision, one-stage operation, and drainage. It will be asked if I suggest that this method should be followed universally. The answer is decidedly no. The procedures I have advocated apply to the operation as performed by hospital surgeons accustomed to neck surgery. They do not apply to surgeons beginning their life work, or to general surgeons, however experienced, who are unlikely to continue to have opportunities of operating upon these cases. The method to be followed will depend on whether the surgeon sees one case occasionally or whether he is likely to be performing the operation with reasonable frequency. Every surgeon has to learn, but until he is thoroughly accustomed to neck dissection I would suggest that he does as I and other surgeons have done—that is, follow traditional lines according to the method of Wilkie and Hartley and of Lahey. Some will be satisfied with this and will choose to make it their practice, and they will be in good company. But when a surgeon is doing much neck surgery and becomes completely familiar with the anatomy and the relationships of diverticula I think he will wish to give his patient something better, and he should have confidence in his ability to do so.

When is operation advisable? Not all cases require operation when the pouch is first discovered. I had had experience of cases where the symptoms were slight, but Dr. Blair and I were indeed surprised to discover the pouch shown in *Fig.* 538 in a patient who had swallowed naturally and easily, and who, four years subsequently, is still unconscious of its presence. Another patient is troubled so slightly that he is content to carry on as he is. A third had some difficulty eighteen months ago before being seen by me, but he now manages his food reasonably well, maintains his weight, and his physician is disinclined to advise operation.* The child of 2 years—now 5 years old—under the care of Dr. Wyllie, owing to her mother's care with her food, manages reasonably well and her weight is average for her age.

In the majority symptoms are pronounced and the pouch has reached considerable size by the time the patient is seen by the surgeon. When this is so further delay is unwise, for the symptoms and dangers already mentioned increase. By this time the pouch has become a menace, as shown by the two patients who died from septic pneumonia and those in whom carcinoma of the pouch developed. I presume a very small pouch can cause dysphagia, but I have not had experience of this and I cannot think that the earlier stages and the small pouch are troublesome enough to necessitate operation. Also operation upon a small pouch presents difficulties

* This patient has recently died.

not present with larger pouches. Physician and surgeon together should naturally decide when operation is in the best interests of the patient, but a point raised earlier is pertinent in this respect. Surgeons who employ the two-stage procedure have so magnified the danger of mediastinitis that some physicians regard the operation as one of great gravity in which the danger of operation outweighs the relief of symptoms, and this fear becomes communicated to their patients. That this statement is not without reason is shown by one physician informing me that he had already told a patient whom we were to see together that it would take a great deal of persuasion on my part to induce him—the physician—to consent to operation. Another patient, whose doctor advised against operation, was one of the two who died from septic pneumonia through inhalation of pouch contents. Three other patients had been repeatedly advised against operation, but because of their sufferings ultimately sought a surgeon who would operate.

THE OPERATION

Preparation for Operation.—The usual careful medical examination will be made. The pouch is washed out by simply drinking and expelling water. The diagnostic X-ray examination will always include careful scrutiny of the sac. If this shows any irregularity, or if there has been any suspicion of bleeding, an œsophagoscopic examination should be made to determine if carcinoma has developed. In very emaciated patients a preliminary gastrostomy may be performed, if desirable under local anæsthesia—or a Ryle's tube passed, with the help of an œsophagoscope, otherwise the tube coils up in the pouch—for preliminary feeding; or the first stage of the Goldmann operation may be performed. I have found a preliminary gastrostomy very helpful with two patients. One (*Fig.* 548) had already lost much weight, and then became unable to swallow anything. This had lasted three days when the patient was seen by me. (This patient was one of those who had, on different occasions, been warned against operation.) Following the gastrostomy, performed under local anæsthesia, dehydration quickly vanished, he gained weight, and feeding was continued through the gastrostomy immediately after the radical operation—to his comfort and mine. In the second case (the patient with carcinoma in the pouch—*Fig.* 536) swallowing had been completely obstructed five days before admission. Gastrostomy was performed because of the urgent need for nutrition. Only after nine days' feeding had the patient improved sufficiently to permit a pharyngoscopic examination. This showed the orifice of the pouch almost completely blocked by the fungating mass, but the lumen of the œsophagus could not be identified. Although this patient ultimately died, the gastrostomy enabled the operation to be carried out without anxiety. For patients who are emaciated but who do not need a gastrostomy, some surgeons perform Hill's operation of diverticulopexy. In these circumstances it would seem to be better—and quicker—to do the first stage of the Goldmann-Hartley-Lahey operation. The patient should then be able to swallow well, and the diverticulum can be resected at a later date.

After-treatment.—Surgeons differ a little in their after-treatment. Some pass a Ryle's tube before, or during, the operation so that fluid may be given early and delivered into the stomach without coming in contact with the suture line. I practised this with several patients, but each of them found the presence of the tube more irksome than abstention from swallowing, and I have now ceased to employ it. It is explained to patients that fluid will be given by the rectal route for forty-eight hours; after that period water is given by mouth, followed in a day or two by tea and other fluids. One pint of saline solution is given immediately after the operation; an hour or two later saline solution is given by the drip method. Plenty of fluid is absorbed in this way and the mouth is kept moist by frequent rinsing. Patients do not mind abstention from swallowing for the two days—possibly helped by the fact that they have suffered so much from dysphagia. By the fifth day jellies and other soft foods are given. There has never been any obvious inflammatory reaction, never a leak, and certainly never a fistula.

Operation Technique.—The region is injected with local anæsthetic solution (novocain 0·5 per cent; adrenaline 1–200,000) because I like the tissue planes to be well defined and relatively free from oozing. Cross lines are inked (*Fig.* 547) with

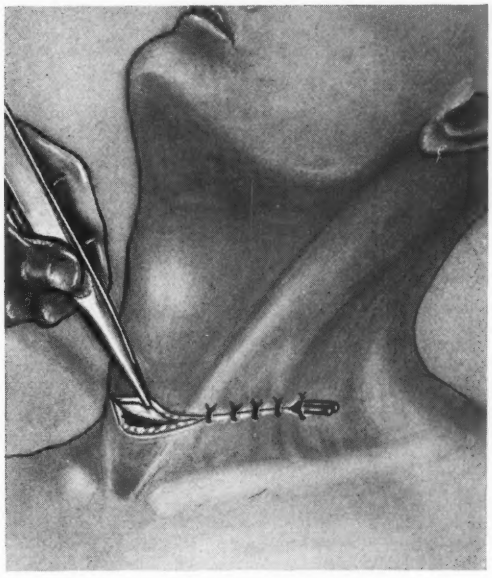


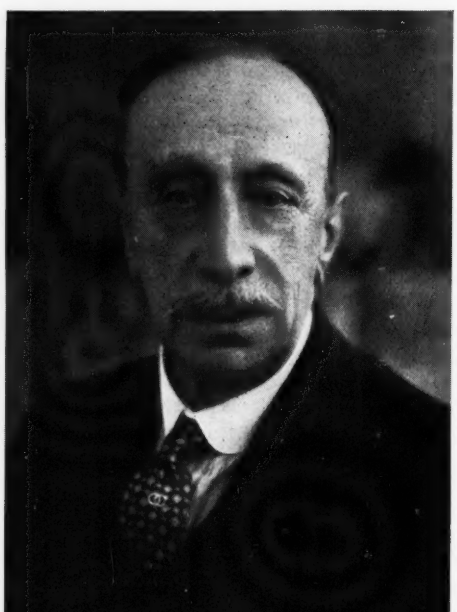
FIG. 547.—Closure of the incision. Compare *Fig.* 542.

Bonney's blue across the line of incision to ensure accuracy of coaptation afterwards. Anæsthesia is induced by intravenous pentothal and is followed by nitrous oxide and oxygen given by the endotracheal method. A left-sided collar incision is made about 1 in. above the clavicle. This begins about 2 cm. lateral to the posterior margin of the sternomastoid muscle on the left and extends about 2·5 cm. to the right of the midline—more if necessary.

The flaps are reflected and a vertical incision made through the deep fascia anterior to the sternomastoid muscle. The infrahyoid muscles are not divided transversely, nor is the anterior margin of

the sternomastoid muscle incised. The middle thyroid vein is divided between hæmostats and ligated. The left lobe of the thyroid is carefully delivered and retracted medially, the carotid sheath

A



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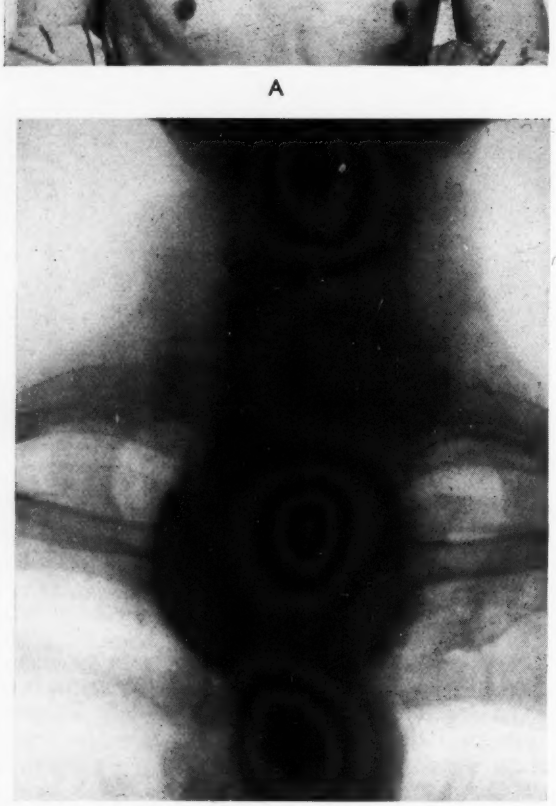

C

FIG. 548.—A, The emaciated patient; B, After operation; C, The diverticulum.

laterally; sometimes the inferior artery is divided. Care is taken not to injure the recurrent laryngeal nerve. The superior thyroid vessels are rarely divided. The diverticulum is readily found and the bigger it is the more easily is it withdrawn by gentle traction and pushing away the areolar tissue with blunt dissecting forceps, sometimes holding a Moynihan's pom-pom. The omohyoid muscle is retracted. When the pouch is withdrawn the space it has occupied is lightly packed with ribbon gauze. The pouch is freed from areolar tissue very cleanly up to its junction with the pharynx. The neck of the pouch must be clearly seen in its whole circumference, the recurrent laryngeal nerve being always kept in mind. At this stage the anæsthetist passes a stomach tube, the point of which enters the pouch but is readily guided by the surgeon into the œsophagus. The fascia propria is incised around the neck of the diverticulum ½ in. from the pharynx—this separates easily from the mucous-membrane layer and the cuff is picked up, around its circumference, with sutures to control and retract it. The mucous-membrane layer is divided, being picked up at each snip of the scissors by light forceps with a slightly curved bite so that they lie on the neck without tension. The stomach tube is seen in the pharynx and the neck of the pouch is clearly seen from the inside. The mucous-membrane layer is accurately sutured with continuous catgut closing the pharyngeal wall. The fascia propria is closed over this with a continuous suture and perhaps a few interrupted sutures. I scarcely need say that hæmostasis must be carried out with meticulous care. When the field is absolutely dry the sternomastoid muscle, which is already practically free from the carotid sheath, is lifted and a hæmostat is pushed through the fascia from the deep surface reaching the superficial surface posterolateral to that muscle towards the left end of the skin incision. The hæmostat is then re-introduced through this opening

from the surface and tubes are drawn along this track, the opening through the deep fascia having been previously stretched by opening the hæmostat, to avoid any constriction of the drainage tubes. These lie naturally and without kinking from the sutured area of the pharynx, deep to the sterno-mastoid muscle, to the lateral end of the incision. The ribbon gauze, which had lightly packed the bed occupied by the pouch, is withdrawn, the wound again inspected to see that no spot oozes, the thyroid lobe is replaced, the vertical incision through the deep fascia sutured, a very small drain, to be withdrawn in twenty-four hours, placed between the deep fascia and the skin on the right side, and the incision closed.

NOTES ON CASES

Some surgeons have written that a radical operation is unwise in elderly or frail patients. Notes on some of the patients are interesting in this respect.

1. The oldest patient operated upon was 77 years of age. When in the upright position with the pouch full, coughing was incessant. Once in a theatre he states that he nearly stopped the performance. When he lay down he felt the pouch empty and the coughing ceased. Because of his age and poor condition, an examination by a cardiologist was made. He was found to have diffuse atheromatous dilatation of the whole of his thoracic aorta and his blood-pressure was 205/130. He was informed of this, but said that his paroxysms of coughing together with his difficulty in swallowing made life not worth living and he wished to be operated upon. Following the operation he remained free from symptoms and ultimately died from intestinal obstruction.

2. A man, aged 71, had the usual symptoms and anginal attacks as well. An electrocardiogram showed early coronary disease. He was subject to periods of severe depression. His operation was performed in 1935. Now—fifteen years later—at the age of 86, he swallows perfectly well and lives a life suitable to his age.

3. *Fig.* 548 shows the man, aged 73, who stated that he filled a chamber twice a day with regurgitated material. His long-standing dysphagia suddenly became acute and for three days he could not swallow anything. He became dehydrated and gastrostomy seemed the wisest way to give him fluid. He gained 14 lb. following the gastrostomy and a further 2 st. following the removal of the diverticulum. The pouch is shown descending into the thorax. The gain in weight is obvious.

4. A woman, aged 65, had suffered from sneezing fits at night only. "Mucous fills my mouth at nights. I cannot swallow it. I have to bring it up. I make such funny noises when I swallow that it is embarrassing to eat in company. It is a dreadful nuisance to me." Following operation, "I sleep like an angel and have no expectoration."

5. A man of 36, with symptoms for six years: "I have not enjoyed a meal for four years. The contents come up and flood the back of my mouth and nose. I have to empty my pouch before I go to bed." *Fig.* 549 shows the pouch entering the thorax and reaching the upper level of the aortic arch.

There is no need to multiply cases; all the patients suffer much the same. They surely have been made to endure too much and too long. The child is in a different category. She appeared to be normal as long as she was bottle-fed. As soon as she was given solid food she vomited, and the pouch was found which is illustrated in *Fig.* 540. Four years later she maintains weight with careful feeding.

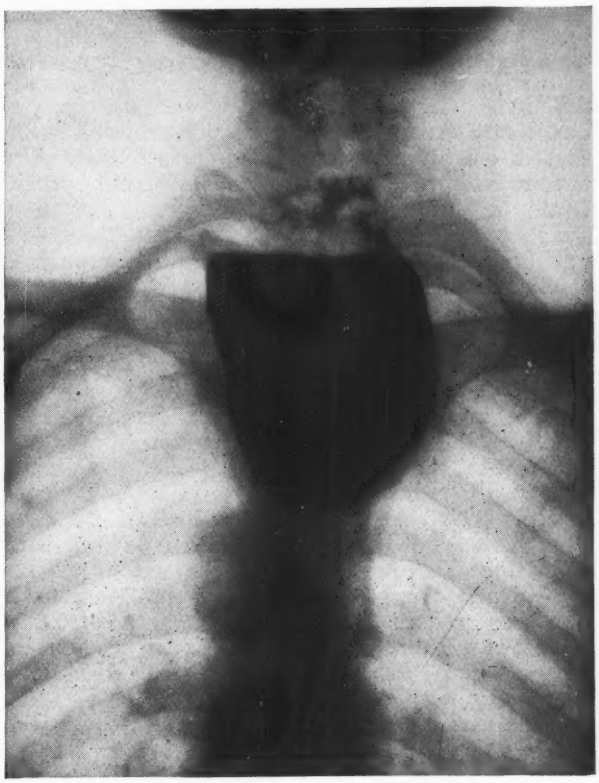

FIG. 549.—A pouch which reaches the upper level of the aortic arch.

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FOREIGN BODIES IN THE CARDIOVASCULAR SYSTEM

By N. R. BARRETT, London

"*A living problem is better than a dead certainty.*"—Frank Jeans, of Liverpool, quoted by Grey Turner.

GENERAL AND HISTORICAL OBSERVATIONS

Upon rare occasion a man, wounded in the heart, lives to tell his tale, and sometimes a foreign body is found imprisoned in the cardiovascular system. Until the turn of the century the results of these accidents were beyond our control, but during the last fifty years such advances have been made—chiefly under the stimulus of two World Wars—that it is now proper to treat such patients actively and to operate upon the heart when necessary.

This paper is concerned with foreign bodies which have come to rest in the cardiovascular system without immediately killing the patient. It is a topic which has occupied the attention of surgeons throughout the ages, and its history has been described in scholarly style by Sir Charles Ballance (1920). The relevant literature is such that any writer who believes his personal case to be 'singular' or 'unique' is probably not well informed, and the task of a reviewer is difficult because many statistical observations have been reduplicated. This subject is not confined to a numerically insignificant group of battle casualties; the problems it presents may confront any man who treats surgical patients, and the case records show that more of those who survive have had civil injuries than war wounds. After the first World War (1914–18) several surgeons reviewed the literature and set out the facts as they were then known, but to my knowledge nobody except King (1941) has recently marshalled the evidence which is now available.

It is my purpose to review selected parts of the literature; to describe the ways in which the blood channels can be penetrated; to report upon the vagaries of solid objects in the blood-stream and to mention the factors which have been held responsible; to remark upon treatment; and to illustrate the whole by references to recorded cases and to my own experience.

The first scientific writings date from the beginning of the nineteenth century—a period when, under the guidance of men like Laennec, careful clinical observations began to be correlated with autopsy studies. In 1868 Georg Fischer published his remarkable monograph concerning the clinical histories and autopsy findings in a series of 452 patients wounded in the heart or the great vessels. In this paper he mentioned the story of a man, whose history Gerard had reported in 1859, and who had lived for six years with a needle embedded in the right ventricle. In 1899 Loison enlarged upon Fischer's work by adding 81 new records—23 of which concerned needles in the myocardium. Some of these patients had suffered no apparent harm, but some had died suddenly and for unknown reasons; and the first successful surgical operations had been dramatically performed. In 1889 Podrez predicted the part surgery would play in saving life and in preventing late complications; he described several patients he had treated successfully.

Callender (1873) was the first Englishman to remove a needle from the heart. The patient was a pewterer, aged 31, who during a brawl in a tavern missed a needle which he had placed in the left side of his coat and fancied that it might have entered in his chest. On the day following he presented himself at St. Bartholomew's Hospital complaining of mild pain but, as there were no physical signs, he was discharged. For nine days he followed his trade, but at length the discomfort behind the sternum became so acute that he came again to the hospital and was admitted. On careful palpation the very tip of the needle could be felt deep in an intercostal muscle; Mr. Callender operated, exposed the foreign body, and, having satisfied himself beyond all doubt that the needle had transfixed the heart near the apex, he took hold upon it and drew it out. The patient recovered and was, from then onwards, quite well.

Thus by 1900 it was known that the heart could not only survive serious wounds and heal well; but cases of weak scar with aneurysm formation had already been recorded (Fischer, 1860; Loison, 1899) and the risks of sepsis were appreciated. Surgeons had realized that some foreign bodies caused dangerous symptoms whilst others were apparently harmless (Riolanus, 1649). Suture of heart wounds was known to be possible and was accepted as indicated in certain emergencies; Baron Larrey (1829), who was Napoleon's surgeon, and Del Vecchio (1895) had operated successfully on dogs, and Rehn (1896 a, b) was applying this knowledge to men.

I shall quote briefly three early case-histories because each shows a special point. The first describes a very large retained foreign body and was written by Davis in 1834. Bland-Sutton (1919) commented upon the circumstances as follows:—

"A boy, aged 10, made a gun of a telescopic toasting-fork. To form the breech of the gun he drove a plug of wood 3 in. long into the hollow handle of the fork and made a touch-hole. When the gunpowder exploded the stick was forced into his chest between the third and fourth costal cartilages, to the right of the sternum. Immediately after the accident the boy walked a distance of 40 yards to his home. He survived the accident thirty-seven days. After death a piece of wood, 3 in. long and as thick as a cedar pencil, was found in the right ventricle of the heart encrusted in clot. Thomas Davis reported these facts in 1834; he found no wound in the pericardium or the heart, and expressed the opinion that the stick, after wounding the lung, had passed into the vena cava and was carried by the blood-stream into the right auricle and then into the right ventricle, where it was found. On reading this report for the first time I was sceptical in regard to the embolic theory that Davis advanced to explain the presence of the stick in the

ventricle, for at the date of the accident surgeons knew nothing of the transport of blood-clot either to or from the heart. It was at least a quarter of a century later that the word embolus was coined by Virchow, and the dangers underlying the movement of clot began to be understood."

FIG. 550.—Copy of a drawing which was made to illustrate the foreign body reported by Davis. The illustration from which this was copied was reproduced in Bland-Sutton's report (1919).

The second case, which dates from the Napoleonic Wars, shows that although a large object may enter the aorta the patient need not die of primary hæmorrhage. The information given below used to be available in the Museum of the Royal College of Surgeons of England (Reference Pathological Catalogue, Part XLIII, dated December 1916, General Pathology, Series XV) but the specimen has been destroyed by enemy action :—

"Mr. Beunton, Assistant Surgeon on board the hospital ship in the Mediterranean, says that a boat's crew, detached to cut-out a French vessel, met with such determined resistance that several were killed or wounded, and amongst the latter was a seaman who affirmed that a musket-ball, striking his oar, had run along it and entered his side ; he bled a good deal and then, almost completing the third day from the injury, he died.

"The post-mortem examination showed that the missile entered the body between the eighth and ninth ribs, it had wounded the diaphragm and passed into the pericardium, which was full of blood ; a hole in the aorta had been made by the shot and this had been closed up by a firm coagulum. Much blood had escaped into the chest and abdomen, not only from the vessels wounded in the course followed by the ball, but from the heart itself. The ball was found adhering to the inner side of the aorta ; and there it is now. (The ball measured 1½ in. in diameter.)

"In the aorta immediately above its valve, there was lodged a piece of skin with the subcutaneous fat (apparently from the axilla) which was carried into the vessel through its anterior wall (now cut away) by the musket-ball which lay immediately above it."

One other historical incident mentioned by Bland-Sutton (1919) is interesting because the foreign body is said to have entered the left side of the heart by penetrating a pulmonary vein.

At the storming of the Great Pagoda, Rangoon, in 1824, a round leaden bullet entered the chest of a soldier between the third and fourth ribs near the anterior fold of the left axilla. Blood and air issued from the wound for several days, and the surrounding tissues became emphysematous. The man was attended in the neld hospital by Dr. J. Fayrer (the late Sir Joseph Fayrer), the symptoms abated, and the patient came under the care of Dr. W. White. The soldier died seventy-two days after being wounded. An examination of the body revealed a pint of pus in the left pleural cavity and a piece of cloth from his jacket. The lung was solid. The track of the missile ran through the chest to the left pulmonary veins. The rifle-ball lay in the left ventricle of the heart near its apex. There was no wound of the heart. It appeared from these facts that the ball had perforated one of the left pulmonary veins, entered the left auricle, and finally passed into, and settled in, the left ventricle. The heart is preserved in the Museum of the Medical College at Calcutta.

The foreign bodies referred to in this paper only include solid objects which have accidentally entered the heart or one of the great vessels ; pathological processes such as fat or air embolism, migratory parasites, and intravascular medicaments are not included. A great assortment of things has been described in the literature and in variety they are only limited by their size. The commonest have been needles : of all types (Loison, 1899), sewing, hypodermic (*see* p. 445), darning (Fair, 1935 ; Dreiling, 1933) knitting, skewers and bodkins, pins, safety-pins (Petersen, 1929), and hat pins. Metallic fragments such as nails (Benard, 1907), pieces of shell, shrapnel balls (Grey Turner, 1941), and bullets (*see Table I*) ; thorns (Kussmaul, 1864) ; spikes of wood (Davis, 1834), pipe stems (Hunter and Staub, 1928), and toothpicks (Bailey, 1913) ; fish-bones (Benda, 1910), spicules of bone ; teeth and parts of dental plates (Braul, 1927) ; brooches, hairpins, and hair grips ; catheters (Blaha, 1935), and radium needles (Lambert Rogers, 1942).

Early experimental work seemed to prove that foreign bodies were unlikely to migrate from place to place inside the lumen of a blood-vessel. Oppel (1901), for instance, introduced needles into the veins of rabbits and found no movements ; Haecker (1907) repeated and confirmed these experiments in dogs. But, by 1918, other investigations and many clinical records had reversed these opinions. Achard and Binet (1918) described how lead pellets introduced into the peripheral veins of dogs travelled about in the venous system. They pointed out that migration was influenced by gravity, by the weight of the pellets, by their shape and size, and by the velocity of the current in the vessel concerned. A round ball, for example, could be induced to roll along inside the lumen more quickly than an object jagged in contour or cylindrical in shape. They also noted a tendency for pellets to lodge in diverticula. Warthen (1927) worked with dogs and came to the conclusion that, as a general rule, foreign bodies in veins were carried towards the heart and that 'migration' could be sudden or gradual. Once the chambers of the heart had been entered the foreign body was often carried into a backwater—such as the auricular appendage or the apical part of the ventricle near to the bases of the chordæ tendineæ ; foreign bodies which had reached the heart were sometimes dislodged from it and

either re-entered one of the venæ cavæ or, more probably, were carried onwards into the current of the pulmonary artery, becoming lodged as infarcts in the lung. He concluded that infarcts of this type were harmless unless the foreign body happened to be infected.

Concerning the heart itself two things have been in dispute: The first was the problem of how a foreign body could penetrate the heart, or even a large blood-vessel, without causing fatal hæmorrhage. The following case throws some light on this point. A negro was recently admitted to the Charity Hospital, New Orleans. He had been stabbed with a narrow-bladed knife, which had penetrated the right ventricle. The wound was explored and it was apparent that bleeding only occurred from the heart when the blood-pressure was high. Bleeding stopped when the blood-pressure fell. Other factors, such as the interlacing layers of the myocardial muscle and the elastic tissue in the aorta, can help to seal off a wound.

The second problem was the cause of death in patients who had sustained a heart wound but in whom profuse bleeding had not occurred. Experiments had shown that the heart as a whole was remarkably tolerant of injuries and that sterile wounds of the myocardium healed without adverse effect, but it had been long held that there were certain 'danger spots' (which were marked out by Tuffier as zones under the warning "*noli me tangere*") which could not be injured with impunity. These were considered to be the interventricular and the interauricular septa and the conducting bundle of His; but there is evidence now to suggest that 'danger-spots' are not anatomically constant, that the nature of the stimulus and whether or not the heart is displaced from its normal position are more important considerations, and that, in spite of much learned opinion to the contrary (Kistin, 1949), the bundle of His does not exist as such. Groedel and Borchardt (1948) have recently made important observations by direct electrocardiography of the human heart, and they state that many of the accepted theories in relation to the electrocardiogram and to the genesis and spread of the excitation wave must be modified. Cardiac death in cases where penetration by a foreign body has not produced massive hæmorrhage is generally due to injury of the coronary system of vessels or to cardiac tamponade.

Much speculation has existed as to how the heart heals after a foreign body has caused a wound and whether the fibrous tissue which results is likely to spread through the myocardium or whether a linear scar can be anticipated. These points are relevant to treatment. There is evidence to show that wounds can heal leaving hardly any trace, but there are also cases such as those first described by Loison and others more recently investigated by Klose (1920, 1923, a, b) in which the scar has given way and an aneurysm has formed; Klose is of the opinion that clean heart wounds can heal without scar by muscle regeneration.

It has been stated that missiles inside the venous system can pass from the pulmonary to the systemic circulation. This implies that the objects can negotiate the lung, and some writers have justified their statement by drawing an analogy between the behaviour of foreign bodies which move about in the muscles and subcutaneous tissues and of fat and air emboli. A typical case of this sort in which air was found in the cerebral arteries and the cerebral veins occurred in my practice and has been described by Philip (1949). The patient died from air embolism whilst undergoing cauterization of intrapleural adhesions. At autopsy many air bubbles were found in the arteries comprising the circle of Willis *and* also in the cerebral veins and meningeal venous sinuses. This patient was found to have a patent foramen ovale and some of the air which had been sucked into one of the veins in a partially divided adhesion had been carried through the right auricle into the systemic system whilst other bubbles had passed up to the surface of the brain in the paravertebral plexus of veins (Batson, 1940). In general the explanation of the fact that a missile has passed from the venous to the systemic system can be found in anatomical abnormalities either in the heart itself or in the great vessels. In certain medical conditions 'paradoxical embolism' or 'crossed embolism' is not uncommon; it occurs for instance in those varieties of congenital cardiac deformity in which there is a shunt of blood through an abnormal communication between the right and the left hearts (Brown, 1939); and Specht (1917) had a patient in whom paradoxical embolism was produced when a fragment of shell passed through a patent foramen ovale. The man had been wounded by artillery fire on February 17, 1917, and had sustained a serious injury involving the thigh muscles of one leg. The wound in the leg was explored three days later and it was found that the femoral artery and vein had been transected by the shot. The torn ends of the vessels were occluded by clots. Amputation was delayed for three days and ultimately the patient died. When the body was examined the heart was normal to superficial inspection, but, upon being laid open, a patent foramen ovale was found and under the posterior wing of the bicuspid valve there was a flat shell splinter the size of an almond which was enclosed in tissue resembling 'amyloid clot'. The splinter was firmly attached to the posterior wall of the ventricle and less firmly to the cusp of the valve. There was no evidence to suggest that the heart itself had been penetrated by the fragment and the author stated that the foreign body had reached the left heart by entering the femoral vein, whence it migrated to the right auricle and onwards, by way of the foramen ovale, to the left ventricle.

FOREIGN BODIES WHICH HAVE ENTERED THE VENOUS SYSTEM

An important aspect of this topic is the various ways in which foreign bodies can get into veins. It is not uncommon to read accounts in which the patients have no knowledge of how or when the accident occurred. Bailey (1913) reported a series of 19 autopsies in which a variety of objects had been found in the hearts of patients, and 14 of these people had not given any history concerning the matter. Goldberger and Clarke (1935) treated a woman who complained of a sharp pain in the precordium and the left shoulder. The pain came on suddenly and there was no accounting for it until radiographs were

taken and revealed a needle buried in the left ventricle. The needle was extracted surgically but the patient died 12 hours later; the cause of death was tamponade due to a hæmopericardium.

Rea and Hoover (1937) gave another example. Their patient was a man aged 70 who had had a cough for many years. He was admitted with an exacerbation of symptoms, vertigo, and severe pain in the left side of the chest. He soon became very ill and amongst other physical signs there was surgical emphysema in the mediastinum and at the base of the neck stretching downwards over the front of the œsophagus and was driven through the wall by peristalsis. The small perforation of the gut sealed off, but some leakage occurred, as was shown by mediastinal emphysema and the pleural effusion. The pericardium and the left ventricle are immediate anterior relations of the lower third of the œsophagus, and the needle could pass directly into the ventricle by this route.

In general the path which a foreign body has taken in its course to a blood-vessel is not in dispute, and the commonest way in which veins have been entered is as a result of wounds affecting the liver.

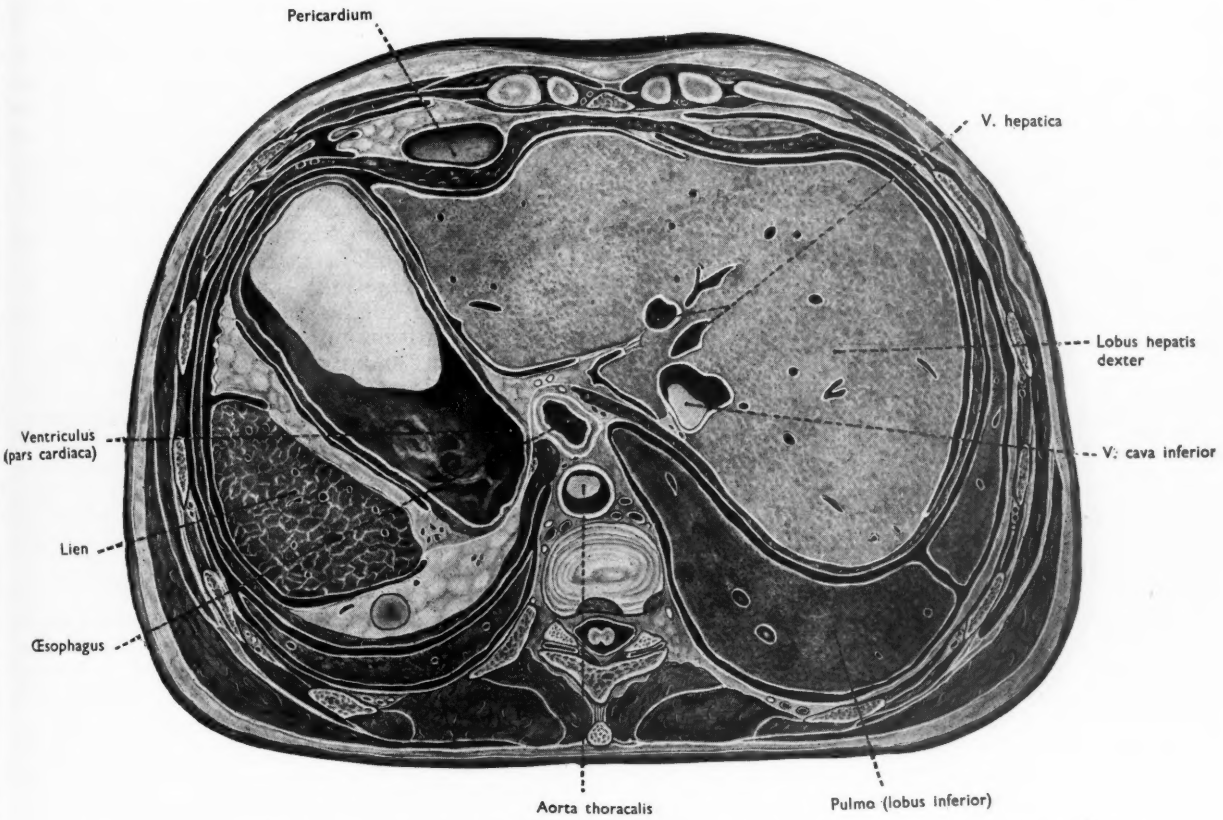

FIG. 551.—This drawing has been taken from Eycleshymer and Schoemaker (Section No. 28). It shows the anatomical positions of the inferior vena cava and of the hepatic veins as they come into relation with the liver.

chest. A left-sided pleural effusion developed and death followed 15 days after admission. At autopsy a needle was found projecting into the cavity of the left ventricle from the myocardium. The authors believed that, in some way unknown, this needle had travelled to the heart from the sole of the foot. The patient had stated that 5 years previously he had trodden upon something sharp in the dark and they suggested that the needle entered the body then and "gradually worked its way upward" through the tissues until it finally reached the lung, thence it had travelled across the pleura and pericardium into the heart. But there is another explanation of these events. The history and physical signs in this case correspond with those caused by a subacute perforation in the lower third of the œsophagus (Barrett, 1946, 1947) and suggest that the needle had been swallowed; that it became impacted in the lower

In such, missiles can pass straight into one of the large hepatic veins or into the vena cava and, because the vessels are supported by liver, they can sometimes accommodate large objects without the patient dying of hæmorrhage. A typical example of such a wound was described by McCartney and Drummond (1917). A large fragment of shell passed through the chest of a soldier and lodged in his liver. The man died of his injuries, but the fragment of metal had been carried in the blood-stream and it was found in the apex of the chamber of the right ventricle. At autopsy the hæmatoma in the liver communicated directly with one of the hepatic veins. This case-history, in common with many others (Menuet, 1917), shows that once an object has got into the lumen of a blood-vessel it is likely to move away from its point of entry and consequently serial radiographs which demonstrate 'migration' are evidence that an object

may be inside a vessel. In the case of veins, foreign bodies tend to migrate towards the heart where they often become caught up or entangled by the chordæ tendineæ, but the following report shows that this does not always happen. Cutler (1923) gave the story of a wounded man in whom a missile crossed the chest and lodged in the liver; within a few hours the fragment had passed through both chambers of the right heart and impacted in a branch of the right pulmonary artery. In this instance the fragment had entered the inferior vena cava and at autopsy the wounded segment of vein was supported by the liver tunnel. I shall quote other examples of foreign bodies which have migrated to a branch of the pulmonary artery, but emphasize now that objects which, upon radiological examination, seem to lie in the substance of the lung may be in a blood-vessel, and failure to appreciate this can result in profuse bleeding at operation. Burckhart (1913) was one of the first to stress that migration to a branch of the pulmonary artery could occur silently.

FIG. 552.

The three following histories illustrate another way in which a fragment of metal or a needle may get into the blood-stream by penetrating a large peripheral vein. Davey and Parker (1947) wrote a description of such a case. A small piece of metal had entered the left axilla and there caused a hæmatoma. The wound was explored soon after the injury and the cephalic vein was found to have been torn; the foreign body which was known to be present had disappeared, and a radiograph taken upon the operating table revealed it to be in the left innominate vein; it migrated from here to the heart and subsequently to the right common iliac vein, from which it was removed. This case illustrates the point that although foreign bodies in veins generally course towards the heart, heavy objects can fall against the stream of blood and under the influence of gravity. Cutler called this movement "retrograde migration" and was the first to say that it was not uncommon. Objects which travel down the inferior vena cava generally lodge in the internal iliac or femoral veins, and the only indication of their movements—unless infection supervenes—is provided by the radiologist. Cases which will be quoted later will show that foreign bodies which have behaved in this way will not certainly remain in the new position but, either early or late and for unpredictable reasons, may suddenly move off once again towards the heart (*see* Grandegérard's case, 1917).

A hypodermic needle used for intravenous therapy may break and 'disappear'. Shapiro (1941) described this accident as occuring in a man aged 45 who was receiving an intravenous injection into the left cephalic vein. The needle broke off at the hilt and disappeared below the skin; it could not be palpated in the puncture. One month later it was located by radiographs and found to have travelled through the heart into the inferior branch of the right pulmonary artery, so that it lay "outside the right ventricle" at the level of the eighth thoracic vertebra. There were no adverse symptoms attributable to this mishap and the author, together with other writers who had had comparable experiences, advocated conservative treatment. For my part I would not advise conservative treatment in such circumstances and for the following reason. A woman aged 33 was referred to me for investigation as to the cause of recurrent small hæmoptyses; she was apparently healthy and there were no physical signs. The anteroposterior radiograph of the thorax showed no abnormality and bronchoscopy was negative; but lateral radiographs of the chest revealed a hypodermic needle lying in the bottom of the left lobe of the lung and concealed in other views by the opaque shadow of the heart. On inquiring as to the possible circumstances in which that needle might have got into the lung—and at the time I was of the opinion that it must have been inhaled into a bronchus—the patient told us that eight years previously she had been investigated for attacks of pyelitis and that whilst an injection was being given into the arm in the X-ray department the hypodermic needle had been lost and was presumed to have fallen to the floor (*Fig.* 552). She suffered no ill effects from this needle (which migrated to her left descending pulmonary artery) for seven years, but after that she began to expectorate blood-stained sputum. The needle and adjacent lung tissue were removed by wedge resection and the patient was cured. The needle had rusted, and it lay in a small, fibrous-walled abscess cavity which communicated with the adjacent bronchus. I believe it fair to assume that this needle reached the lung from the antecubital vein and I know from other cases that although metallic objects retained in the lung may seem harmless they can cause trouble at any time.

A foreign body may lodge partly inside and partly outside a vein, plugging the hole in the vessel so that fatal bleeding does not occur. Such an event can happen if a bullet sticks in the front of the body of a vertebra, leaving the exposed end inside the lumen of the inferior vena cava. I was present at a laparotomy when an unsuccessful attempt was made to extract such a missile, and in retrospect it was apparent that the fatal primary hæmorrhage which occurred might have been avoided if the vessel had been temporarily clamped above and below the

missile. Sheppe (1922) recorded a somewhat similar event; a bullet traversed the abdomen and transfixed the inferior vena cava. An attempt was made to remove it by laparotomy, but upon being grasped, the smooth surface slipped through the surgeon's fingers and it disappeared. The rent in the vein was sutured but the patient died of peritonitis seven days later. The bullet had migrated to the apex of the right ventricle and it is recorded that careful auscultation and clinical examination did not reveal signs of cardiac dysfunction during life.

Tuffier (1918) wrote about a rifle bullet which had entered the abdomen in the lumbar region and slowly 'eroded' the wall of the inferior vena cava. Six weeks later it had reached the right ventricle. An attempt was made to remove the bullet from the heart, but the operation was not successful and the soldier died after three days. At no time had he complained of any symptoms referable to the cardiovascular system or shown signs of having a large foreign body in the vena cava.

Another way in which the venous system can be entered is as a result of slow erosion of the wall of a vein by an adjacent foreign body; this accident is not uncommon when radium needles have been inserted for treatment into and around malignant growths. Two examples will be mentioned.

Lambert Rogers (1942) reported the history of a patient who had had radium needles implanted into a growth situated in the left posterior triangle of the neck; after some days one of the needles had disappeared. The missing needle was subsequently removed from a branch of the right pulmonary artery, having got into the venous system through the wall of the internal jugular vein. This process was not necessarily associated with bleeding, as both this case and the next prove. In 1928 a woman, aged 86, who had had a papilloma removed from the face three years previously, was admitted to St. Thomas's Hospital (1929). The tumour recurred and was locally excised on several occasions until at the time of her last admission it had formed a plaque of malignant tissue in the cheek with a fixed mass of malignant glands in the right supraclavicular area. Small (1-mg.) radium needles were implanted into both areas and after an uneventful convalescence the needles were drawn out fourteen days later. Two were missing. The patient was X-rayed and the report stated that one of them lay deep in the neck near the body of the seventh cervical vertebra. On the following day the other was located in the pelvis —it was assumed that this needle had ulcerated into the gullet and been swallowed, but a barium enema revealed it to lie *outside and behind* the bowel (*Fig.* 553). The patient's condition began slowly to deteriorate and three weeks later B. W. Williams, assisted by Sir Cuthbert Wallace, did a laparotomy, but after prolonged exploration the search failed. A week after this operation the patient died and at autopsy some interesting points were noted. The patient had died of her malignant disease; the lost needle lay in a branch of the right internal iliac vein; it could not be found by palpation at autopsy and was only located when the individual veins had been opened; the needle, which assay showed to contain active radium salt, had not caused histological damage to the wall of the iliac vein and it was therefore assumed that it had not entered the cervical vein as a result of a radium burn leading to necrosis; there was no thrombus in the iliac vein even though a piece of silk several inches in length was still attached to the needle and floating free; there was no abnormality in any of the neck veins to mark the spot where the needle had entered the internal jugular. I assume that it entered one of the great cervical veins; that it dropped down the superior vena cava, through the right auricle, into the inferior vena cava and so down to the internal iliac vein.

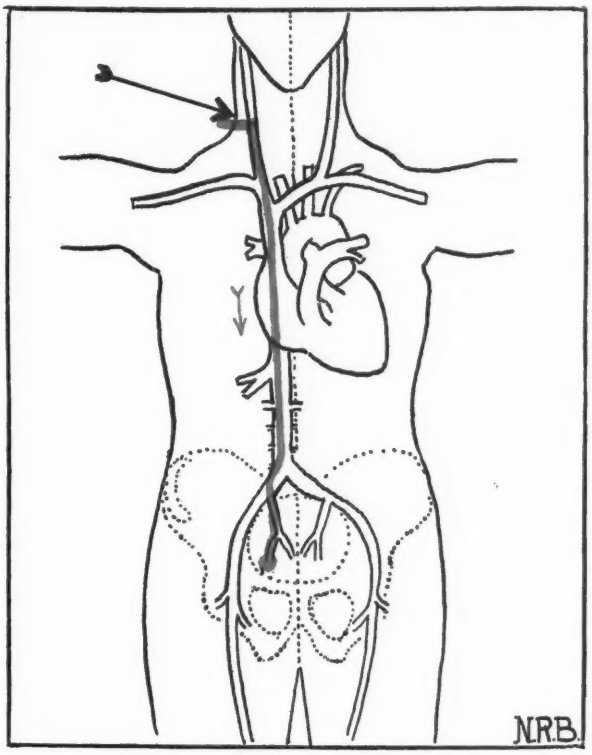

FIG. 553.

Another possible portal of entry to the venous system is from the alimentary canal and there are three anatomical sites at which this is reported to have occurred. The first is by penetration of the piriform fossa. The gullet is thin at the level of this cul-de-sac which lies adjacent to the internal jugular vein. A small sharp object, delayed in deglutition by a temporary spasm of the cricopharyngeal sphincter, can be forced by coughing, choking, or vomiting through the wall of the pharynx. Duhan (1940) had a patient "who swallowed a needle in some rice" and choked. He straightway came to hospital complaining of pain in the throat, but a laryngoscopy, performed within a few hours, revealed no abnormality; sixteen days later the needle could be felt under the skin of the neck behind the middle of the left sternomastoid muscle; it was removed under local anæsthesia. This record shows that penetration of the gullet can occur, and the following information which F. C. Ormerod (1949) has kindly sent me carries the matter further: "The case I told you about was a lady, as far as I remember in her sixties, who was admitted to the Birmingham and

Midland Ear, Nose, and Throat Hospital while I was House Surgeon there in 1921. She came with a history that she had swallowed a fish-bone and attempts had been made to remove it with the expanding probang. She was unable to swallow, but examination by the œsophagoscope did not reveal a

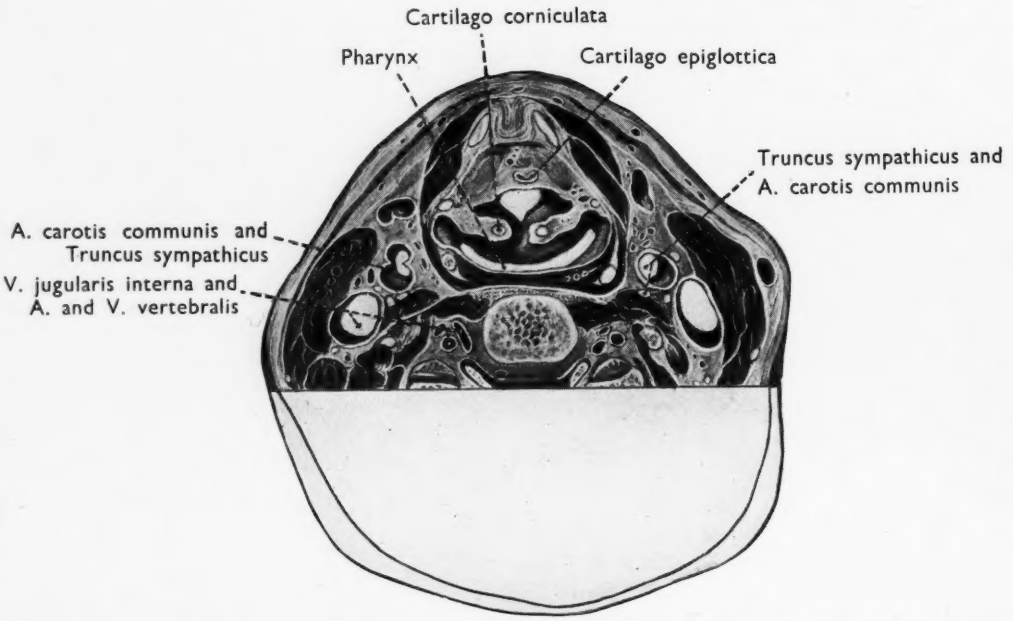

FIG. 554.—This drawing was copied from Eycleshymer and Schoemaker's book. It shows how a foreign body, which had perforated the piriform fossa, could get into the great vessels of the neck.

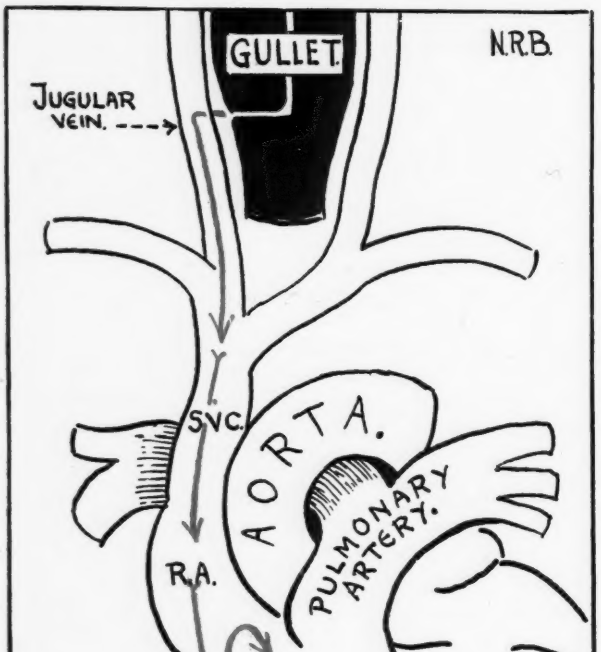

FIG. 555.

foreign body. A Ryle's tube was introduced into the stomach and she was fed through this for several days. The power of swallowing then returned for a little while, but later she complained of pain in the throat. Examination then showed a redness and a slight swelling of the lateral wall of the lower pharynx on the left side. She developed bronchopneumonia about this time and rapidly succumbed to it. At post-mortem I found a sharp straight fish-bone, some ¾ in. long, with its point lying between the carotid artery and the jugular vein. The other end of the bone lay in an abscess cavity which partly surrounded the great vessels and was in intimate relationship with the wall of the pharynx. The bone had passed or been forced through the wall of the pharynx and lodged between the vein and the artery. I had the specimen at Golden Square for many years, but unfortunately it disappeared during the last war".

My experience is of a little girl, aged 2, whose father handed her several 'Kirby grips' (steel wire hair slides). (*Fig.* 555.) The child put them into her mouth and immediately choked. She was not actually seen to swallow any of the 'Kirby grips', but her father thinks she gave him back one less than he had given her. Shortly afterwards the child had a "shivering attack" and vomited. She appeared to be flushed and ill. During the night she vomited several times and a *rigor occurred*, but by the morning she seemed to be in good health except that she refused her breakfast. The attacks of shivering and sickness returned on the next afternoon and a doctor was called. She still would not eat and admission to a hospital was arranged. Five days after the first symptom the child, who was in hospital, was radiographed and a wire hair slide was seen lying "below the diaphragm" parallel with and close to the right

side of the bodies of the 10th, 11th, and 12th thoracic vertebræ; it lay ¾ in. in front of the bodies of the spine, and the points were directed downwards (*Fig.* 556). Three days later another set of films and a barium meal showed that the foreign body had risen upwards a little and that it was lying outside the stomach and duodenum. A laparotomy was performed on that day but the surgeon was unable to

FIG. 556.—Film showing the 'Kirby grip' to be lying alongside the bodies of the lower thoracic vertebræ and at this time it was already in the lumen of the inferior vena cava.

remove the 'Kirby grip' which he could feel "above the diaphragm in the posterior mediastinum" (*Fig.* 557). A fortnight later the child was transferred to another hospital, where a radiograph showed the foreign body to be within the shadow of the right ventricle (*Fig.* 559). Her general condition was fairly good at this time but she was pyrexial; this temperature was considered to be due possibly to endocarditis, but a blood-culture was negative. Five weeks after the original episode the child was admitted to Sully Hospital in Wales. Her general condition was good and up to this moment she had received 3,800,000 units of penicillin and 4½ g. of sulphamezathine. There were no physical signs in the chest or elsewhere, but radiographs and cardiac catheterization proved that four-fifths of the wire lay in the right ventricle, that the upper fifth projected through the auriculo-ventricular valve into the right auricle and that the points were directed upwards (*Fig.* 561). One week later I took the foreign body out of the heart. The operation was done through a right-sided transpleural incision and although it was not possible to feel the wire in the heart its position was known to such a nicety that the right auricle was opened with confidence. Before this thoracotomy was performed an attempt had been made to dislodge the foreign body from the ventricle back into the superior vena cava or into the internal jugular vein by holding the child upside down and shaking her

FIG. 557.—Film taken after laparotomy, showing that the hair slide is still in the same position in relation to the vertebral column, but that it has moved upwards a little in the vena cava.

FIG. 558.—A lateral film corresponding to the radiograph in *Fig.* 557.

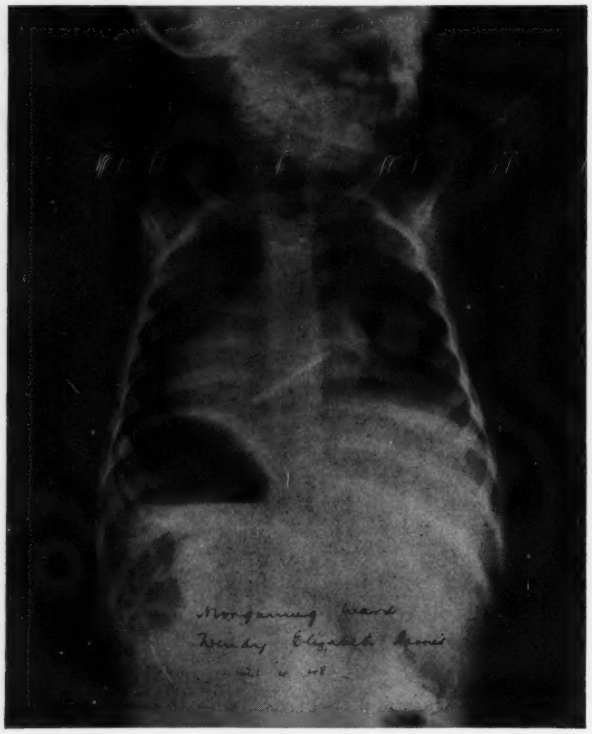

FIG. 559.—Film showing that the foreign body now lies within the shadow of the heart. (This film has been printed back to front.)

FIG. 560.—A lateral film which was taken at the same time as the film shown in *Fig.* 559, and which—taken in conjunction with *Fig.* 559—proves that the hair grip is now in the heart.

FIG. 561.—In this film a cardiac catheter has been passed. The tip of the catheter has curled up in the right atrium, and this proves that the foreign body is now lying partly in the right atrium and partly in the right ventricle: its position is demonstrated to a nicety.

FIG. 562.—Lateral view taken after that shown in *Fig.* 561. The catheter has now been manipulated so that the tip has passed through the tricuspid valve, and it lies alongside the lower part of the foreign body in the ventricle. Note that in passing from the inferior vena cava to the ventricle the foreign body has turned around so that the points now face upwards.

violently. As the wire could not be moved in this way it was assumed that it must be held in a mural clot inside the ventricle, and this proved to be the case for as the ' Kirby grip ' was extracted it brought with it a fairly large piece of clot which was cultured and yielded a mixed growth of nonhæmolytic streptococcus and *Clostridium welchii*. This child has been followed up for more than a year and remains in perfect health. The post-operative electrocardiograms have always been normal, and the fever subsided early in convalescence.

record. Bailey (1913) has gathered together some interesting cases of this type. In one a patient swallowed two false teeth on a gold plate and the plate penetrated the œsophagus and pericardium, causing death from suppurative pericarditis. In another a fish-bone pierced the wall of the stomach at the cardia ; the pointed end passed through the diaphragm and entered the heart so that it lay with one end in the stomach and the other in the left ventricle. In two others there was a history of swallowing a foreign body, which was found later in

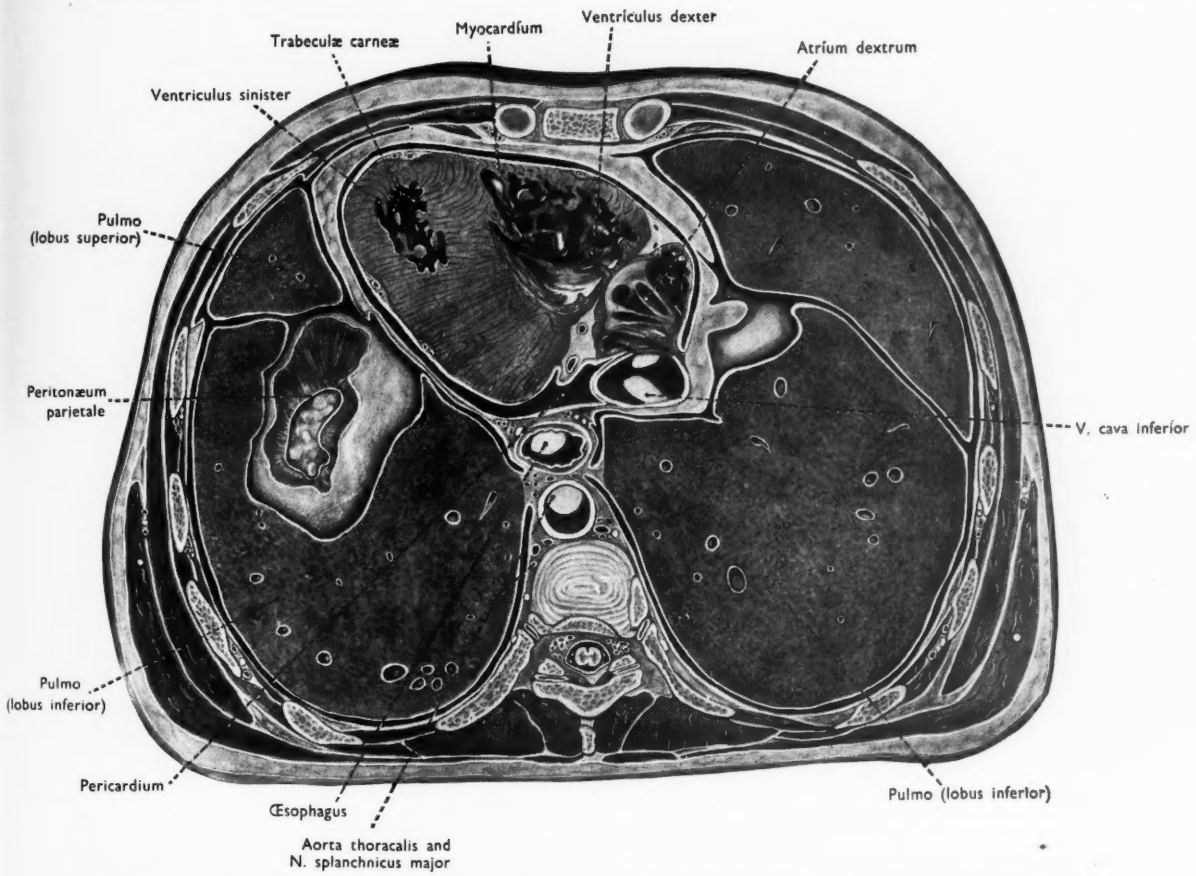

FIG. 563.—Drawing copied from Eycleshymer and Schoemaker's book (Section No. 27), showing how a foreign body might pass from the lower œsophagus to the pericardium or to the wall of the left ventricle.

I believe that in this case the wire hair grip was ejected from the pharynx straight into the right jugular vein and that from here it fell through the heart into the inferior vena cava, passing downwards until the points had caught up in the mouth of one of the renal veins. After the laparotomy and whilst the child was lying in bed the wire was carried away in the blood-stream into the right ventricle and there became fixed. The alternative possibility is that it perforated the duodenum and entered into the inferior vena cava, but I submit that the early onset of rigors and shivering (within a few hours of the accident), associated with the fact that the wire was certainly in the vena cava in less than four days, are arguments against duodenal perforation.

Foreign bodies can get into the heart or the pericardium from the lower third of the œsophagus (*Figs.* 563, 564) and many examples are on

the heart, but no lesion to indicate the route followed. The two following cases are of interest because of the long time the objects must have been in the heart and the absence of symptoms attributable to their presence. The first was reported by Ambrose (1870) and this patient swallowed a pin ; nine years later the man died of a perforated gastric ulcer and the pin was found in the wall of the left ventricle ; it is most likely to have got there by perforating the lower œsophagus. In the second case, reported by Kussmaul (1864), a thorn—*Prunus spinosa*—covered by a thick layer of fibrin was free in the cavity of the right ventricle. The thorn had been swallowed eighteen months previously and the patient died of pulmonary tuberculosis ; the alimentary canal was normal.

Pathological processes affecting the lower end of the œsophagus may involve the heart and pericardium,

if they lie anteriorly, and the aorta if posteriorly. Barrett and Franklin (1949) have described the history of a patient who died from perforation of an acute peptic ulcer of the œsophagus into the pericardium, and there are numerous accounts of patients dead from hæmorrhage due to septic penetration of a foreign body backwards into the aorta.

Foreign bodies in the alimentary canal which have successfully negotiated the cardiac end of the stomach very seldom perforate the intestine. Siddons (1939) reviewed the histories of 126 patients who had swallowed foreign bodies and who were judged to need admission to a hospital; only 3 of these sustained intraperitoneal perforations of the intestine and in 2 the event passed unnoticed; the objects were found later on in the peritoneal cavity. Macmanus (1941) was only able to find 95 cases in the whole literature of foreign bodies which had perforated the intestines; half of these were metallic objects and three-quarters of them perforated the ileocæcal region. It follows that the double event of perforation of the duodenum and entry into an adjacent vein must be very rare indeed, and careful search reveals only two possible instances in the literature. Benda (1910) found a fish-bone in the superior mesenteric vein, but in this patient there was nothing to suggest how it got there. Bailey's case (1913) is definite. A man, aged 49, entered hospital complaining of nausea, fever, and muscular pain. The symptoms, which had been present for fourteen days, followed upon a " spree of five days' duration " and had started with continuous vomiting. There was no abdominal pain at any time and no abdominal signs except slight distension and varying tenderness. Pyrexia continued and a blood-culture yielded *Str. viridans* and *B. coli communis*. He grew worse and died of " septicæmia and pneumonia ". At autopsy there were scattered foci of bronchopneumonia, but the pericardium contained 75 c.c. of unclotted blood, and protruding 1·5 cm. from the tip of the right auricle was the point of a wooden toothpick which measured 6·8 cm. in length. The other end could be felt in the auricle and was fixed in place by soft " chicken fat " clot. Adherent to the surface of the pericardium were small flakes of fibrin. On the posterior wall of the duodenum, 14 cm. beyond the pylorus, at the point where the intestine passes immediately in front of the inferior vena cava, there was a small area of ulceration, and extending backwards from this to the vein there was a sinus. The opening in the vena cava was 8 cm. below the entrance of the hepatic vein.

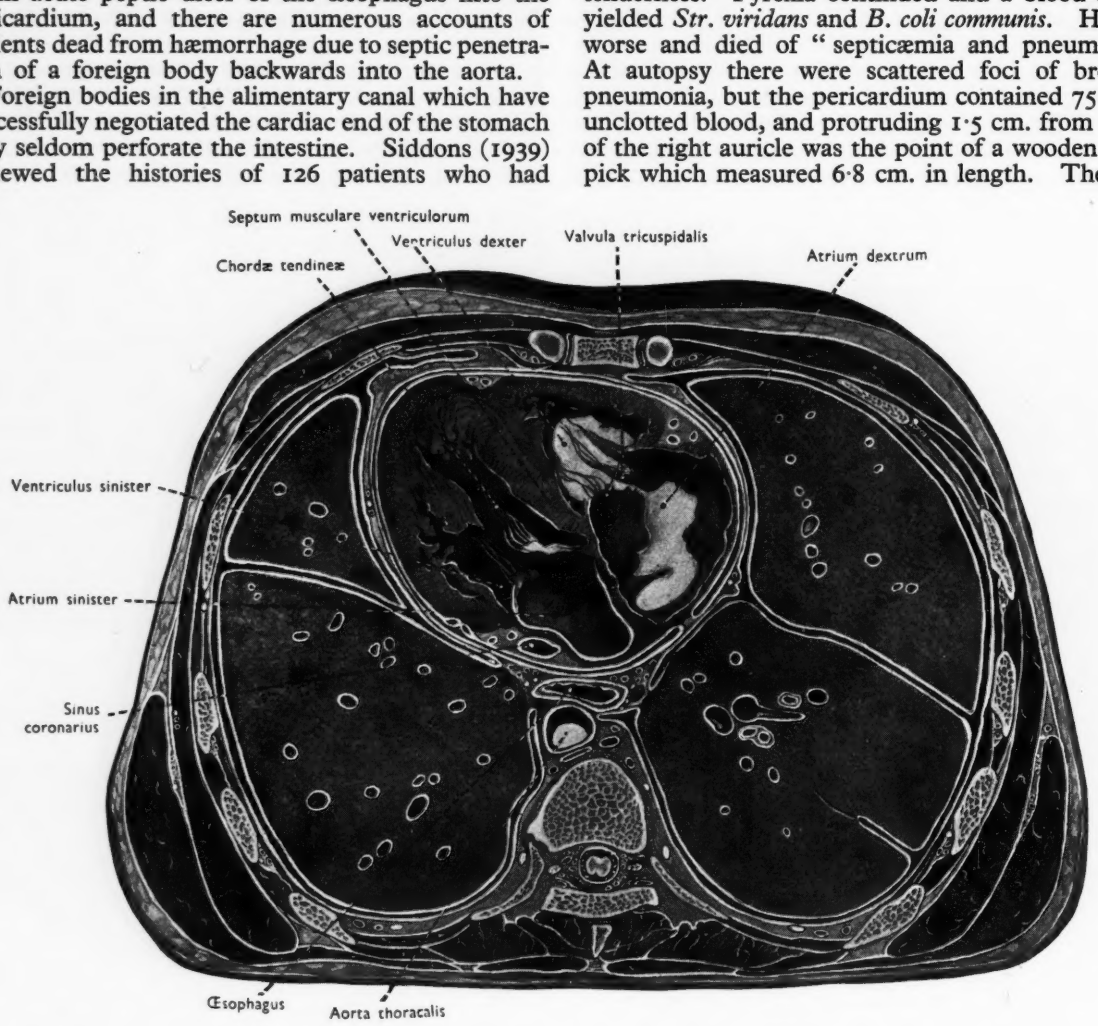

FIG. 564.—This drawing was copied from Eycleshymer and Schoemaker's book (Section No. 26). It shows the proximity of the œsophagus to the atrium sinister on the one hand and to the thoracic aorta on the other.

The only other reference I have found to perforation of the stomach or duodenum is in Bland-Sutton's book (1930) *The Story of a Surgeon*, in which he recorded that an ostrich which died at the London zoo was found to have in its gizzard a piece of wire 6 in. long, one end of which had entered the portal vein.

Apart from the routes of entry to the venous system mentioned above there are isolated examples of most unusual happenings. Blaha (1935) had to

deal with this strange case: A woman was admitted to hospital with a history that 24 hours previously she had introduced a catheter into the uterus to produce abortion. As soon as she did this she had experienced a sharp pain and had started to bleed. Gynæcological examination on the first day revealed no injury of the vagina or the cervix and the catheter could not be seen, but on the following day a perforation of the right parametrium was diagnosed and a laparotomy was performed. At operation no perforation of the uterus was found and the abdomen was closed and the placenta removed by curettage. It was presumed that the catheter must have fallen out without the patient noticing it. By the fifth post-operative day the patient had developed septicæmia and multiple lung abscesses and 48 hours later she died. At autopsy the rough, broken-off lower end of a semi-rigid rubber catheter 23·5 cm. long and 4 mm. thick was found in the lumen of the inferior vena cava. It stretched upwards through the right auricle into the superior vena cava and onward as far as the left internal jugular vein. In the lungs there were multiple abscesses and throughout the body there were the manifestations of septicæmia. The abdominal viscera were not abnormal apart from sepsis in the liver and spleen, but there was a perforation of the uterus 2 cm. above the os and lying posteriorly so that there was a direct communication between the uterus and the lumen of the right hypogastric vein.

The author explains the sequence of events as follows: after perforating the cervix, the catheter must have penetrated a large vein of the uterine plexus; it slid directly into the right hypogastric vein and then into the inferior vena cava. As there was no severe hæmorrhage the catheter must either have obliterated the lumen of the vein or hæmostasis was produced by clot in the vessel. The catheter remained in the hypogastric and inferior vena cava (autopsy showed that the extent of the gangrenous and thrombophlebitic changes corresponded to the length of the catheter) and caused gangrene and suppurative thrombophlebitis of the hypogastric vein; this inflammation spread up the inferior vena cava and down the retroperitoneal tissues and eventually produced the abscesses in the lung. These changes show that the catheter remained in this position for some days and the symptoms suggest that it was only on the fifth day after its introduction into the uterus that it was carried into the heart, possibly as a result of sudden violent movement on the patient's part (she was very restless). The only symptoms of this occurrence were sternal pain, a sudden increase in the pulse-rate, and an attack of coughing—none of them alarming. A small, flat thrombus was found firmly adherent to the endocardium of the auricle adjacent to the catheter, and this shows that part of the foreign body must have been for some time in the right auricle or there would not have been signs of organization of the clot. The

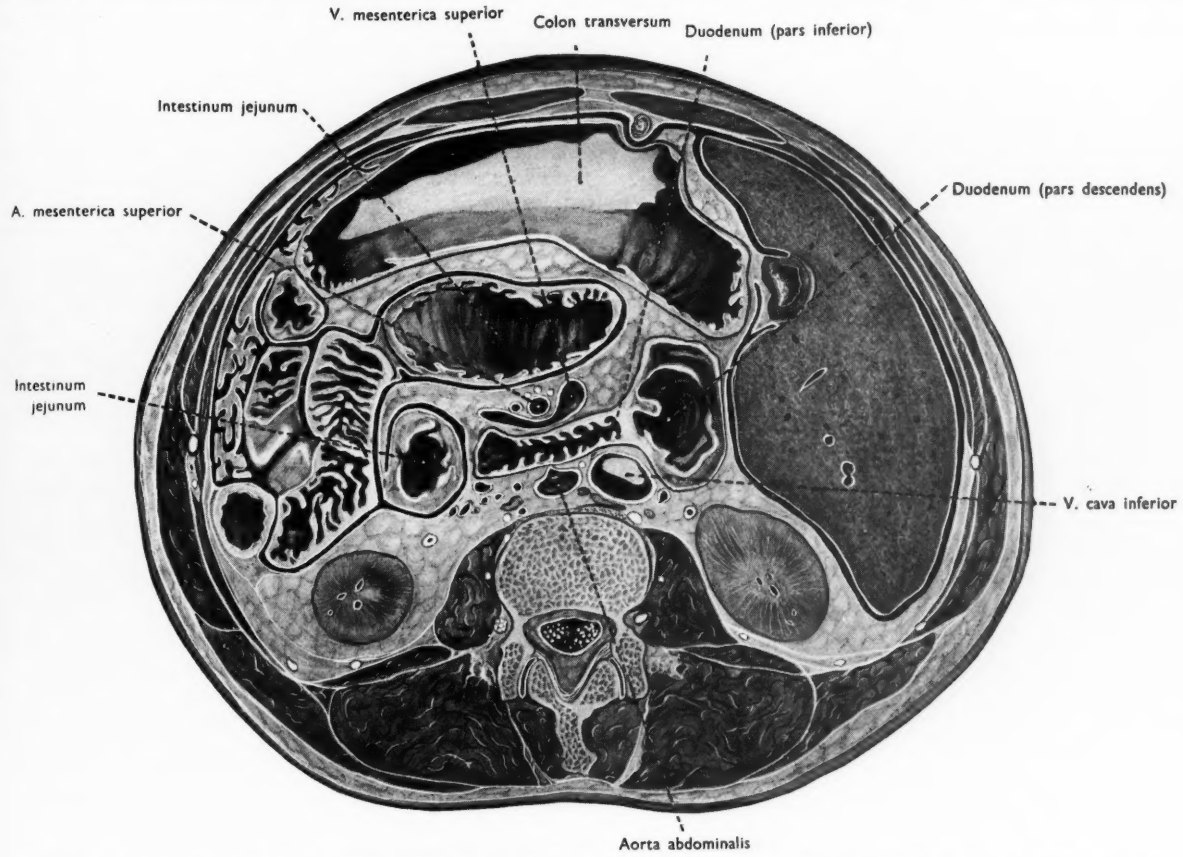

FIG. 565.—A drawing copied from an illustration (Section No. 33) in Eycleshymer and Schoemaker's book, showing how a foreign body which perforated the pars inferior of the duodenum might get into the superior mesenteric vein or into vena cava inferior.

foreign body must have lain for 48 hours in the heart without impeding its activity.

Perforation of the vagina or uterus by a catheter introduced to produce abortion, with subsequent wandering of the catheter into the abdominal cavity, has been reported 43 times according to the author, but he found no other case of migration of a rubber catheter into the heart, nor has he found any mention of such a large foreign body being carried in the blood-stream.

There are records of patients who have died as a result of sewing needles, radium needles, or radon seeds, which have punctured the wall of a bronchus

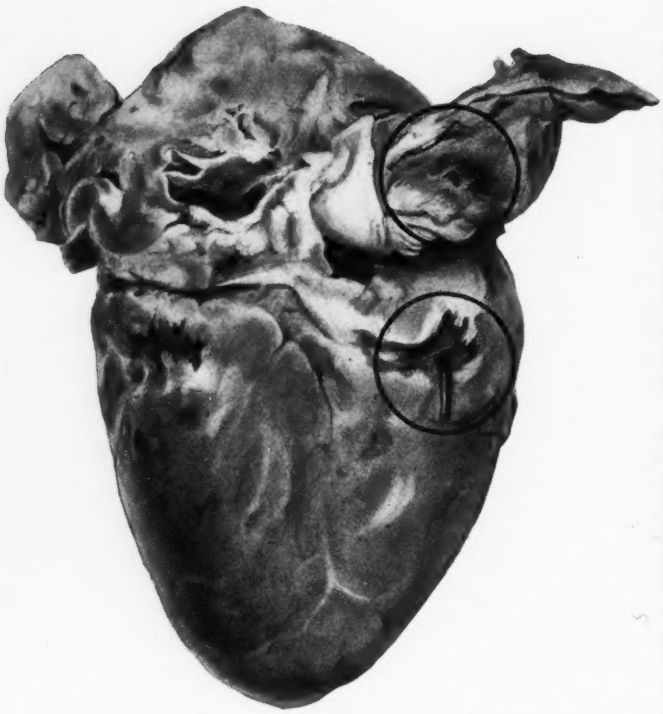

FIG. 566.—"The lower circle surrounds the end of the toothpick which protrudes from the posterior tip of the right auricle. The upper circle surrounds the surface of the pericardium at the point where it has been roughened by contact with the protruding end of the toothpick." This illustration, and the above legend, have been copied from Bailey's paper (1913).

and entered the pulmonary artery on the left side or the pulmonary veins or arteries on the right, but I cannot find any instance of a patient who has survived this accident.

One point which is particularly relevant to treatment must be further exemplified—namely, the speed at which objects are likely to migrate from one place to another in the venous system. Davey and Parker's case (1947) has already been quoted, but the fact was known a long time ago. Grandegérard (1917) told of a soldier who was wounded on October 10, 1916, and remained well until a week had passed, when he began to notice pains in the chest. Fluoroscopy revealed an opaque mobile object in the right auricle. One hour later, at another investigation, nothing abnormal could be detected in the chest, but the foreign body was then seen to be in Scarpa's triangle. A few minutes later it shifted again and lodged in one of the branches of the internal iliac vein, from which it was removed after two days. This patient was one of the first in whom migration of a foreign body in a blood-vessel was *proved* to have occurred.

FOREIGN BODIES WHICH HAVE ENTERED SYSTEMIC ARTERIES

Wounds which involve large arteries are generally fatal, but some extraordinary circumstances have been recorded in which the patients have survived. This applies particularly to wounds of the aorta, and it is my impression that although missiles sometimes enter this artery they rarely get into peripheral arteries. This is in contrast with the frequency with which peripheral veins are entered. The histological structure of the aorta may have some bearing upon the subject; its walls contain much elastic tissue and it has been shown that the intima has remarkable powers of healing. Short linear incisions in the aorta tend to close spontaneously, and although the pressure in the vessel is high, clot can plug an incision successfully. By contrast injuries or experiments in which a piece of the wall of the aorta is punched out do not seal off so readily. Sir George Makins (1919) in his book *Gunshot Injuries to the Blood-vessels* gave examples of "spontaneous closure of bullet wounds of the abdominal aorta"; and he was able to confirm the healing of the aorta at autopsy on several occasions.

If a missile or a foreign body transgresses the aorta or enters its lumen, and the patient does not die immediately, it is unusual for a false aneurysm to occur; the commoner sequence—in the case of the thoracic aorta—is that the mediastinum becomes infiltrated with blood and a hæmothorax develops; but if the missle passes at the same time through the vena cava at a place where it lies adjacent to the aorta then an arteriovenous communication can be expected. There are cases in which each vessel has had a wound of entry and a wound of exit; the outer wounds have sealed off and healed, whilst the two which face each other have persisted to form a permanent communication between the artery and the vein. Fry (1920) recorded a curious case of this type in which a missile entered the body close to the anterior-superior iliac spine, went straight through the left external iliac artery, and entered the accompanying vein, thus producing an arteriovenous aneurysm between these two vessels. Meanwhile the foreign body migrated up the vena cava to the right heart and thence to the left pulmonary artery, in which it finally came to rest.

An object may transfix a large artery in the same way as has been described in the case of the inferior vena cava, and the following record exemplified this point: Edmundson (1935) wrote an account of a native man, living in Tanganyika Territory, who was shot through the front of the chest by an arrow. He was brought in a distance of 15 miles and walked unaided into the operating theatre. "The iron shaft of an arrow-head protruded 1 in. from the sternum. It was about $\frac{1}{2}$ in. to the right of the midline and opposite the second interspace. It protruded almost at right angles to the sternum, the direction being backwards and slightly upwards. This shaft was seen to vibrate rhythmically with the pulse and on placing the finger lightly on the tip a

transmitted thrill was felt. On auscultation near the shaft a loud systolic murmur was audible which was conducted up into the neck on the right side. The pulse on admission was 100. There had been very little external hæmorrhage up to this time, although obvious endeavours had been made to cut and pull out the arrow head". An operation was performed and the mediastinum was found to contain a small amount of blood-clot. The barbs of the arrow were freed and the missile was drawn out. Withdrawal was immediately followed by massive and fatal bleeding. "Examination of the body showed that there had been a complete transfixion of the aorta by the arrow, which had entered the arch on its convexity, and had penetrated the posterior wall at the junction of the innominate and the aorta. The inner coat of the vessel showed a few superficial excoriations as if the point of the arrow had moved to and fro in the lumen. There was no marked internal hæmorrhage. The arrow had pierced the sternum in such a manner that the two barbs just impinged on the under surface of the sternum, the points being fixed by the barbs in the aorta and the tissues posterior to it . . . Removal of the plug formed by the arrow head was followed by splitting of the muscle under the pressure and instant death . . ." The man had lived for thirteen hours; he had survived the efforts of his friends to extract the arrow by cutting and pulling. He died as a result of the operation, but his life might have been saved to-day, for the knowledge which has accrued as a result of operations performed in the treatment of coarctation of the aorta (Crafoord, 1948) has proved that both resection of a part and anastomosis are possible.

A B

FIG. 567.—Fatal perforation of the lateral wall of the right pyriform fossa. A, Seen from behind; and B, In front. A probe has been passed through the perforation.

The above facts indicate that the aorta can be penetrated, that the wound can seal over, and consequently that upon occasion a foreign body can enter the systemic circulation. But, unlike veins, arteries are seldom entered by foreign bodies except as a result of a penetrating wound.

Some further case-histories will be quoted to illustrate special points.

La Roque (1926) treated a negro man, aged 36, who was attacked and shot by an assailant from above. The bullet entered the left chest internal to the vertebral border of the scapula and the victim began to run; he continued running for some time until a sudden and paralysing weakness of the left leg forced him to stop. On admission to hospital the

left leg was weak and ischæmic, and pulsation could not be felt at any of the usual points. Clinical examination revealed a massive hæmothorax in the left pleural cavity, but with treatment his acute collapse improved, an adequate collateral circulation gradually developed in the leg, and, fourteen days after the wounding, Scarpa's triangle was explored. No injury or superficial hurt to the vessels could be detected, and the bullet was successfully extracted by ligating and removing short segments of the artery and vein. It was assumed that this bullet had entered the thoracic aorta.

In Keen's *System of Surgery* (1921) there is a chapter which deals with this subject and many examples are mentioned; from these I deduce that, whether the missile be free in the left side of the heart or in the aorta it can ultimately migrate and impact in a peripheral vessel. Gangrene of the affected extremity may occur or it may not, and I have been unable to find the essential points which would enable a surgeon to prognose upon this possibility. For instance de Rouault's (1919) patient was not as lucky as the negro whose story is described above; the missile entered the aortic arch and became impacted in the left femoral artery; the circulation to the limb failed, gangrene set in, and the patient died. Boeckel (1916) had a similar story to tell; his man developed gangrene of the leg from a bullet lodged in the femoral artery which had migrated from the cavity of the left ventricle. It seems that, as with pathological emboli so with embolic foreign bodies, there are certain anatomical locations which are potentially more dangerous than others—namely, the lower part of the brachial arteries, the femoral, and the popliteal vessels. It is striking that there is seldom any clinical evidence of migration, apart from the sudden effects of ischæmia produced in some cases, so that the majority of the patients remain unaware of any change in the position of the foreign body.

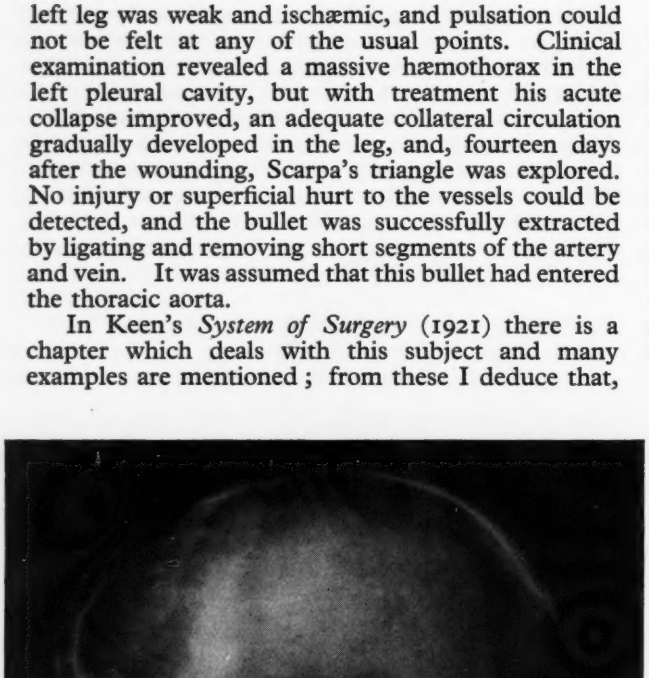

FIG. 568.—Radiographs sent to me by Professor Morelle, of Louvain, showing a lead shot which migrated from the neck to one of the cerebral vessels. (Professor Debaisieux's patient.)

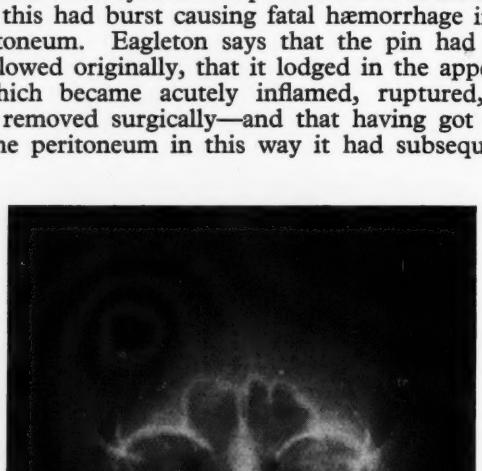

FIG. 569.—Anteroposterior view of the same patient as shown in *Fig.* 568. The small lead shot can be seen within the shadow cast by the rim of the right orbit.

It is possible for an object to enter a large artery by slow ulceration and Eagleton (1943) had a patient in whom he considered that this had happened. A negro soldier, who had been admitted to hospital on several occasions for treatment of syphilis, died suddenly. At autopsy a pin was found lying in the abdominal aorta; it had given rise to a small traumatic aneurysm in the posterior wall of the artery and this had burst causing fatal hæmorrhage in the peritoneum. Eagleton says that the pin had been swallowed originally, that it lodged in the appendix —which became acutely inflamed, ruptured, and was removed surgically—and that having got loose in the peritoneum in this way it had subsequently "ulcerated" through the wall of the aorta. A more convincing example of this type of case was reported by Negus (*Fig.* 567) (Negus and Thomson, 1948). He had a patient, aged 55, who noticed a pain in the neck whilst eating cake; this man developed dysphagia which passed off after ten days. He was admitted to hospital complaining of cough, expectoration, and hæmoptysis. Four days later a swelling appeared in the neck, caused by rupture of the common carotid artery, and it was found that a perforating foreign body had caused a parapharyngeal abscess which had led to sloughing of the wall of the artery.

Two references to foreign bodies which entered large peripheral arteries and then acted as emboli have been sent to me by Professor J. Morelle, of Louvain (1949). The first patient was a man aged 32 who was admitted to Professor Debaisieux's service (Louvain) with a history that six months previously he had been wounded in the left side of the neck by pellets from a shotgun. Immediately after the accident he became aphasic and developed a right-sided hemiplegia. A few hours later he was unconscious and he remained in coma for fifteen days, after which his condition slowly improved,

but he was left with his hemiplegia and aphasia unchanged. Radiographs showed many lead pellets in the neck and one inside the skull. As there was no wound upon the head it was presumed that the pellet which had caused the neurological symptoms must have entered the carotid artery and been carried upwards in the blood-stream until it impacted in a branch of the middle cerebral artery. A very similar case was reported by Lecéne and L'Hermitte (1920) and referred to in the book concerning cerebral embolism written by Maurice Villaret and Rene Cachera (1939). During the 1939–45 war a soldier, aged 30, whose arteries were healthy, was wounded in the neck by a fragment of metal the size of a hemp-seed. This tiny foreign body entered the carotid artery and was carried up to lodge in a branch of the middle cerebral, which it occluded. The man became hemiplegic and aphasic and died six days later. The facts were verified at autopsy.

It is strange that foreign bodies, which apparently get into the venous system relatively easily, should so rarely be found after arterial wounds; the two cases mentioned above are the only examples I have traced of missiles which have got into peripheral arteries other than the aorta.

FOREIGN BODIES IN THE HEART

The foregoing account has included examples of foreign bodies which have reached the heart as emboli; the present description includes those which have entered it directly from the surface of the body. The usual way for a foreign body to get into the heart is for it to pass through the chest wall. Zezas (1910) reviewed a series of 118 cases in which various objects had got into the heart and he found that of these 96 had passed directly through the chest wall, 12 had migrated from the alimentary canal, 4 were embolic from other places, and 1 came from the respiratory tract.

In 1949 Fritz and others did experiments in which metallic foreign bodies were introduced into the hearts of 62 dogs and the pathological effects were noted. They concluded that sterile foreign bodies placed in the pericardium did little harm and that they became sealed off in a fibrous tissue shell in about eight weeks. Thirty-five foreign bodies were placed in the chambers of the heart and of these all but 3 migrated to the pulmonary artery or to systemic blood-vessels; little harm seemed to result from these experiments. Metallic objects were then introduced into the myocardium of 18 dogs and 2 of these animals died—one from sepsis and one as a result of an injury to a coronary vessel—but the rest survived and appeared to be normal.

FOREIGN BODIES RETAINED IN THE MYOCARDIUM

In times of peace, pins and needles are the usual objects to be found, but in war, bullets, fragments of metal, cork, and clothing are more common.

During the last century it was fashionable to attempt suicide by driving a pin or a skewer into the heart. Thomson (1888) refers to this practice and Foot (1888) recorded that Admiral Villeneuve killed himself in this way; he had commanded the French fleet at Trafalgar and was taken prisoner and brought to England. After staying two months in England he was released and returned to Rheims, from which city he sent a message to Napoleon that he was on French soil again. He was suffering from depression at the time and had already been reprimanded by Napoleon for inefficiency, so that when he failed to receive an answer he drove a long needle into his heart.

This method of suicide did not produce consistent results and some of the people concerned survived. Cases of all varieties have been described in the literature and before the close of the nineteenth century pins and comparable objects had often been taken out by surgeons in Europe and America (Loison, 1899; Foot, 1888; Callender, 1873; Wyman, 1889; Turner, 1896; and Prior, 1897; and others). In the majority of the early cases the needle was extracted by grasping the end, which could generally be palpated in an intercostal space or subcutaneously, and slowly drawing it out; various refinements of rotary movements were considered to be important in those days. These records indicate that, although this simple procedure could give safe results (Cope, 1920), bleeding often occurred (Fair, 1935).

No foreign body should be removed nowadays without formerly exposing pericardium and performing the operation under direct vision. Sellors and Whigham (1948) have recently described a case in which some details of the modern approach to such a problem are considered. Their patient was a woman, aged 38, into whose heart a large darning needle had been driven by a blow upon the front of the chest. The needle remained in the heart, without causing disability, for four days and was then extracted successfully.

Since operations upon the heart have become part of the routine work of a thoracic surgeon removal of foreign bodies from the myocardium or the chambers of the heart is a resonably safe procedure in most cases, but before deciding whether to operate we must enquire whether such foreign bodies are likely to be harmless if left alone.

Needles and pins, small pieces of metal, shrapnel balls, and bullets can, upon occasion, be retained for years without apparently affecting the patient adversely and without damaging the heart. In this group are considered the patients who have not only survived the accident but have progressed in convalescence to a state of cure. Fritz (1949) states that 4 Russian surgeons, namely, Likhtsier (1945), Gomaleya (1943), Gerke (1944), and Lidskiy (1945) have collected 128 patients who survived for periods of more than four months with foreign bodies in the heart and who showed no serious clinical or subjective signs; Bland (1944) described 8 others who were treated conservatively for short periods after they had been wounded and who suffered no harm. But in addition to these records, which concern patients who have only been followed up for relatively short periods, there are others—as *Table I* shows —who lived longer without apparent hurt.

In many of the recorded cases the critical reader will feel that sufficient data is not available to be sure that irreparable injury has not been done to the heart, and it may be that closer scrutiny would have shown that function had been impaired. Moreover, the pathological effects of a missile may not be

apparent for years after the original injury, for it is possible that, by severing or causing thrombosis in a branch of a coronary vessel an infarct, may develop, or that contused muscle replaced by scar may stretch and form an aneurysm. But it cannot be assumed that the results which are known to follow pathological coronary occlusion will be comparable

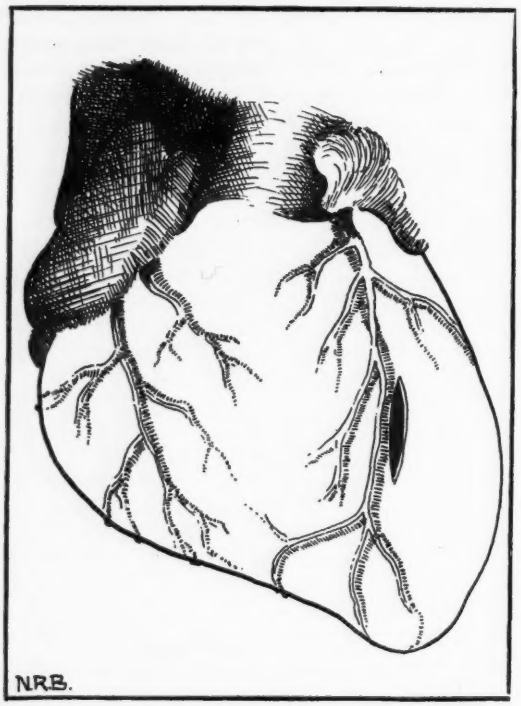

FIG. 570.—Copy of a diagram in the paper by Charles Olim, showing the site and the extent of the laceration which he closed by sutures which encircled the adjacent coronary vessels.

with the effects produced by trauma in a heart which has been normal up till the moment of injury. The following record supports this contention : Olim and Hughes (1939) treated a negro, aged 24, who had been stabbed in the heart* with the long blade of a pocket knife. The wound was exposed and consisted of " a laceration 1·5 cm. in length on the anterior surface of the left ventricle approximately 2 mm. to the left of the left anterior descending coronary vessels and about 5 cm. from the apex. The laceration penetrated the chamber of the left ventricle, and as soon as the tamponade was released great streams of blood spurted." The only way in which the wound could be closed was to place " four interrupted silk sutures . . . so that the coronary vessels were encircled " and occluded. This operation was performed under local anæsthesia. " Following the placing of the first suture around the coronary vessels and until the pericardium was closed (10 minutes) . . . the myocardium distal to the ligated vessels was carefully observed for signs of ischæmia. No change in the colour of the muscle was noted." The patient experienced no pain from the sutures or the ischæmia, and three months later he had no demonstrable cardiac abnormality.

Having established that foreign bodies can lodge in the pericardium, the myocardium, or the interventricular septum and become walled off without producing symptoms and without apparent deviation from normal cardiac function, I must show that unfavourable complications can also occur.

These complications have been divided into two groups—namely, effects such as hæmorrhage, infarction, tamponade, recurrent pericardial effusions, and infection, which occur early ; and neurosis, pain, aneurysmal dilatation, migration, thrombosis, and embolism, which can happen at any time up to 30 years after the foreign body has entered the heart. In the assessment of a case disturbances of function have been considered more important than the exact anatomical location of the foreign body, and these disturbances range from a feeling of tightness in the chest to irregularities of rhythm and dyspnœa on exertion.

Tuffier (1920) stressed that in the literature there are many records of patients who had foreign bodies retained " harmlessly " in the heart, who were apparently well, and yet who died suddenly for no reason which could be found at autopsy.

Physicians have stated that the function of the heart may be unaffected by a retained foreign body, but it is now agreed that the clinical and laboratory tests at our disposal are not adequate to assess local conditions satisfactorily. The following case proves this point :—

In June, 1945, I operated upon an officer who had been wounded two months previously. The missile had passed through his cigarette case, which he carried in his tunic, and a second small fragment of metal was punched out and carried into the chest wall. At the casualty clearing station his condition was poor because he was suffering from shock, but there was no change in the rhythm of the heart-sounds, no tamponade, and no exit wounds. He was treated expectantly and developed a hæmothorax on the left side, which was successfully treated by repeated aspirations. Four weeks later he arrived at Sully Hospital in Wales and his condition was good ; the hæmothorax had resolved and there were no clinical signs or laboratory tests to suggest residual suppuration or cardiac abnormality. The electrocardiogram was normal. He was anxious to rejoin his regiment, but radiographs showed a foreign body embedded in the front of the heart and, as a result of Harken's experiences (q.v.), it was decided that this ought to be removed. The operation was done under general anæsthesia and when the pericardium had been exposed it was seen to be opaque and scarred by multiple adhesions in the area over which the left phrenic nerve and vessels passed ; the lung was adherent to the pericardium in this region ; but there was no evidence of active inflammation or of pericardial effusion. The pericardium was opened and a zone of induration 1 in. by ¾ in. in size could be felt in the left ventricular myocardium but the foreign body was not palpable. A hollow needle was, therefore, taken and, using this as a sound, the missile was located about ½ in. from the surface of the heart. Having placed two rows of sutures along

* About 600 cases of stab wounds of the heart had been reported up till 1939 and many more must have been treated. The first successful operation was performed by Cappelan, of Norway (1896), and the second by Rehn, of Frankfurt (1896).

Table I.—Some Examples of Foreign Bodies retained in the Heart or Pericardium for Long Periods without apparently causing much Harm

Author	Sex and Age	Description of Foreign Bodies	Mode of Entry and Position in Heart	Symptoms	Length of Time retained	Cause of Death. Way in which Facts were ascertained	Comments
Bland (1944)	M. 25	Bullet, ·30 calibre, 2·3 cm. long	Entered in left pectoral region. F.B. lying within the shadow of right heart. Two-thirds embedded in the wall of the heart	Occasional substernal discomfort	5 mth.	Seen on X-ray. Alive and well 5 months after injury	Pericardial and pleural effusions 6 and 9 weeks respectively after injury
Fair (1935)	M. 60	Needle, 3 in. long. ¼ in. in diameter. Used to mend canvas laundry bags	Right ventricle	No symptoms	7 mth.	Seen on X-ray. Well 7 months after injury	Unsuccessful attempt made to remove F.B. 3 hours after injury
Northrup (1913)	F. 1	Sewing needle, 2 in. long	Child fell out of cradle and at that time mother noted a protrusion just below the ensiform cartilage. Found in left ventricle	Ailing child from time of injury	1 yr. 3 mth.	Pneumonia. F.B. found at autopsy	Diagnosed as having congenital heart disease
Thole (1917)	M.	Russian bullet	F.B. entered left lower chest. Found in wall of right ventricle	No symptoms	15 mth.	Death 14 days after operation to remove F.B. Cause of death "paralysis of heart"	
Dujarier (1916)	M.	Bullet	Wounded in left chest. F.B. found in right ventricle	No symptoms. Remained on active service	16 mth.	Seen on X-ray. Removed 16 months after entry. Uneventful convalescence	
Peterson (1929)	M. 26	Safety-pin, 12 cm. long, 1·2 mm. in diameter	Pin stuck into left chest. At autopsy the pointed end of a brass pin was found protruding into the pericardial sac. The pin penetrated the left atrium and curved over on the right side of the vertebral column in a slightly downward direction	No symptoms	18 mth.	Committed suicide 18 months after injury	An unsuccessful attempt was made to remove pin 2 days after its entry. Whenever the pin was touched the patient showed signs of collapse
Escande and Brocq (1917)	M. 28	Bullet	Entered chest 2 cm. below left nipple. On X-ray the base appeared to be in the interventricular septum. The point seemed to be in the bottom of the left ventricle	Slight dyspnœa on exertion	2 yr. 4 mth.	Well 28 months after injury. Bullet seen on X-ray	Returned to duty 9 months after wounding
Christison (1888)	M.	Bullet	Right ventricle	No symptoms	2 yr.	Died of pleurisy. Bullet found at autopsy	
Le Fort (1917)	M.	Bullet	Right ventricle	Not stated	30 mth.	Removed at operation 30 months after wounding	Complete recovery
Brémond and Mariau (1919)	—	Bullet, 23 mm.	F.B. entered at 5th left intercostal space in nipple line. Bullet lodged in the pericardial sac	No symptoms	4 yr.	Seen on X-ray. Alive and well 4 years after injury	Unsuccessful attempt to remove bullet 15 days after wounding
Swearingen (1923)	M. 45	Bullet, 32 mm.	Bullet entered through 5th intercostal space ½ in. to left of sternum. Screening showed F.B. just posterior to wound of entry and within the shadow of the heart approximately midway between the right and left borders and approximately 2 cm. below the greatest diameter of the heart	None	4 yr.	Alive and well 4 years after injury. F.B. seen on X-ray	Self-inflicted wound
Koch (1921)	M. 40	Bullet	Entered chest at level of the 8th right rib. Seen to lie in the muscles of the heart	None	5 yr.	Seen on X-ray examination. Alive and well 5 years after injury	Working as a miner
Dupuytren (1832)	M.	Bullet	Right ventricle	None	6 yr.	Not stated	

Continued on next page

Table I.—SOME EXAMPLES OF FOREIGN BODIES RETAINED IN THE HEART OR PERICARDIUM FOR LONG PERIODS WITHOUT APPARENTLY CAUSING MUCH HARM—*continued.*

AUTHOR	SEX AND AGE	DESCRIPTION OF FOREIGN BODIES	MODE OF ENTRY AND POSITION IN HEART	SYMPTOMS	LENGTH OF TIME RETAINED	CAUSE OF DEATH. WAY IN WHICH FACTS WERE ASCERTAINED	COMMENTS
Burgess (1934)	M. 38	Machine-gun bullet	Left ventricular wall	Not many for 6 years, then pain, syncope, palpitations	9 yr.	Bullet removed by operation	Completely well 20 years after wounding and 10 years after operation
Decker (1939)	M. 29	Bullet	Entered at 7th left costal cartilage, 2–3 cm. from midline. Seen on X-ray to be lying in the pad of fat between pericardium and diaphragm	For first 2 years after injury pain in region of heart. Palpitation and dyspnœa on exertion	9 yr.	Alive 9 years after injury with no symptoms. F.B. seen on X-ray	
Ambrose (1870)	F. 31	Pin	Swallowed pin. At autopsy found near the apex of the right ventricle and just beneath the endocardium	None	9 yr.	Peritonitis. Pin found at autopsy	At P.M. the pin was found to be closely encysted and completely traversing the whole thickness of the ventricular wall with its point covered only by its own cyst and the visceral portion of the serous layer of the pericardium. The pin had become so brittle as to break from slight pressure. There were no symptoms of inflammation nor of irritation of the heart; no hypertrophy, no dilatation. The pericardial cavity contained about an ounce of serum but no lymph or pus.
Hentz (1929)	M.	Bullet	Bullet entered 3 in. above tip of the ensiform cartilage. Held by adhesions in most dependent part of pericardium	Slight loss of vitality	10 yr.	Alive and well 10 years after injury. Bullet seen on X-ray	
Wasch and Epstein (1933)	M. 23	Bullet, 22 mm.	Left ventricular myocardium	None	12 yr.	Seen on X-ray	
Grey Turner (1941)	M.	Musket-ball	Penetrated front of chest and was found at the origin of the great vessels and protruding into the wall of the left auricle	None	14 yr.	Died of tropical remittent fever. F.B. found at autopsy	
Gilchrist (1929)	M. 23	Spherical ball of shrapnel	Shrapnel entered back. Seen on X-ray "within the pericardium and dimpling into the surface of the left ventricle"	None	13 yr.	Alive and well 13 years after injury. Seen on X-ray	
Gilchrist (1929)	M. 24	"Fragment of metal"	F.B. embedded near the posterior aspect of the left ventricle	Dyspnœa on sudden exertion	14 yr.	Alive 14 years after injury. F.B. seen on X-ray	Another fragment of metal in the left lung near the hilus
Risel (1910)	F. 55	Three separate pieces of a needle	Swallowed. One fragment in outer wall of right ventricle, another (probably eye of needle) in left ventricle, middle piece in muscles of heart tip	None	14 yr.	Woman died of intestinal obstruction. F.B. seen on X-ray	This woman suffered from a depressive anxiety state and swallowed "everything she could lay hands on"
Hamilton (1867)	M. 14	Leaden bullet	F.B. entered right shoulder through the upper border of the trapezius muscle about 2 in. from the acromion process. Found in the wall of the right ventricle near the septum at the most dependent part of the ventricle	Five years after injury had pneumonia and at that time "a very tumultuous action of the heart" was noted, which increased until his death	20 yr.	Congestion of the right lung. F.B. found at autopsy	Bullet passed through two roof boards and a board partition before entering the man's shoulder
Grey Turner (1941)	M. 32	Service bullet (1914–18 war)	Entered ½ in. below and ½ in. external to left nipple. X-ray: bullet embedded in the wall of the left ventricular septum; its movement is synchronous with the cardiac contractions	None	24 yr.	Alive 24 years after injury	Attempt to remove F.B. 39 days after injury was unsuccessful

Table I.—continued.

Author	Sex and Age	Description of Foreign Bodies	Mode of Entry and Position in Heart	Symptoms	Length of Time Retained	Cause of Death. Way in which Facts were Ascertained	Comments
Lott (1912)	F. 10	Part of the shaft of a needle	Penetrated the chest wall. At P.M., "projecting through the interventricular septum was part of the shaft of a needle firmly fixed in position by dense fibrous tissue; the end projecting into the left ventricle was broken off when opening the cavity, the piece broken off was ¼ in. long; the other end projected into the right ventricle	None known	29 yr.	Generalized paralysis and pneumonia. F.B. found at autopsy	Patient died in a mental hospital 29 years after injury
Groly (1864)	M. 22	Bullet	Bullet entered the left breast. At autopsy bullet was found lodged in the pericardium, encysted, beneath the right auricle between the orifices of the superior and inferior vena cava	Bronchitis 2 years before death	52 yr.	Bronchitis. Bullet found at autopsy	The heart was very much hypertrophied and dilated

the edge of the proposed line of approach through the myocardium, an incision was made down to the fragment of metal and, on reaching it, *an abscess was entered out of which came about one ounce of offensive pus*. This abscess was, I believe, situated in the myocardium superficial to an organized mural clot inside the chamber of the left ventricle. There was no bleeding when the heart was cut. Penicillin and sulpha powder were left in the cavity and the abscess was closed by tying the sutures which had already been put in place to control possible hæmorrhage. The patient made an uninterrupted convalescence and was discharged fit; eight months later he was examined by a cardiologist and stated to be normal. The pus from the abscess was sterile on aerobic culture but anaerobic organisms must have been present.

I have quoted this case to emphasize that a foreign body, harmless according to all possible

FIG. 571.—An anteroposterior view of the thorax, showing two foreign bodies situated within the shadow of the heart and slightly above the left diaphragm.

FIG. 572.—Lateral film taken at the same time as that shown in *Fig.* 571. This suggests that one of the foreign bodies, namely the posterior one, the outline of which is indistinct from cardiac movement, lies within the heart.

methods of investigation, may be lying in an abscess cavity in the myocardium. Nevertheless it seems reasonable to suggest that small, smooth metallic objects which have been in situ for a long time are, in fact, walled off by fibrous tissue and attempts to expose and remove them are not likely to be easy or successful. Couteaud and Bellot (1914) recorded a case in which a bullet had lodged in the wall of the auricle from May 14 until November 9, and they stated that "the vigorous fibrosis which surrounded the bullet resembled a veritable fibroma, its capsule averaging one and a half centimetres in thickness".

The fate of jagged objects is not satisfactory and there is special evidence to show that, if the patient survives the wounding, complications are probable later. Such missiles often carry in small pieces of clothing and other foreign bodies and the risk of inflammation and suppuration is high. Harken (1946), who treated a number of these patients surgically during the last war (1939–45), stated that he had personal experience of three soldiers who had died from massive hæmorrhage caused by septic erosion of a large vessel. He also quoted the following statistics: 15 per cent of patients in his series had an abscess in the myocardium; in 30 per cent additional foreign bodies, such as pieces of clothing, etc., were present as well as the missile; and 67 per cent of the foreign bodies he extracted from the heart or from the pericardium were infected. He gave it as his belief that, even in the uninfected cases, the fibrosis which he found around the missile was such as to cause, in all probability, progressive damage to the cardiac musculature.

Schaefer and Satinsky (1946) declared that there were three principal dangers of leaving a foreign body lodged in the myocardium—namely, the heart might rupture if an aneurysm were to form; a coronary vessel might be involved in scar tissue; or the foreign body might enter the heart and migrate elsewhere.

FOREIGN BODIES WHICH HAVE ENTERED A CHAMBER OF THE HEART

A foreign body in a chamber of the heart may be retained or act as an embolus, and examples of both possibilities have already been quoted. It remains for me to enlarge upon certain additional points.

Objects up to the size of a rifle bullet can pass into the heart without killing the patient, and there is evidence to prove that all parts of the heart heal well after an incision has been made into one of the chambers. One of the most striking cases recorded by Harken (1947 a, b) was that of a U.S. paratrooper whose right heart he opened upon three occasions, all within the space of a few weeks, and from whom he eventually succeeded in extracting the missile. He emphasized at the last operation that it was difficult to see where the previous incisions had been made. The patient returned to his military duties and was graded a fit man.

The myocardium heals so quickly that it is generally impossible to say how a foreign body has got into the heart if the patient survives a few days. But once it has entered one of the chambers it can remain mobile, riding up and down upon the fast current like a ping-pong ball upon a jet of water. This dramatic appearance has been seen and described by radiologists who have screened such patients. In these circumstances it is liable at any time to migrate to a branch of the pulmonary artery in the lung from the right ventricle, or to a peripheral artery from the left side of the heart. The fact of its mobility is an important clinical point in advising and devising treatment, but unfortunately the point cannot be certainly shown by radiographs. Baumgarten (1919) observed a soldier who had been shot by a machine-gun bullet which entered the left ventricle on September 22, 1918, and was demonstrated to be mobile in the heart on October 12; but on October 22 it suddenly migrated to the bifurcation of the right common iliac artery and was still in this position on December 12. It was removed by laparotomy seven days later and the artery was found to be filled with a thrombus at the point of lodgement. At no time did the patient experience pain or show evidence of ischæmia, and the outcome of the operation was good.

Although most foreign bodies which migrate from the right ventricle lodge in a pulmonary artery, this does not always happen, and Simmonds (1882) was one of the first to stress this point. In a personal communication Mr. G. Mason (1949) has told me of a missile which migrated from the heart back into the inferior vena cava. A soldier was wounded on March 6; he sustained multiple injuries, one of which consisted of a penetrating wound near the left nipple. Two days later the wound was explored; blood was found in the pericardial sac, but the missile could not be detected and the incision was closed. On August 24 the man came under the care of Mason, who operated with the object of removing the foreign body which radiographs now showed to be in the abdomen opposite the first lumbar vertebra; he found that it was inside the lumen of the vena cava in the region of the renal veins and it was left in situ. A month later the man was discharged in good condition and without symptoms.

In contrast to foreign bodies which move about in the chambers, there are others which become fixed and held fast. Keith (1917) wrote that he had experience of seven different bullets retained in soldiers' hearts and, in all, the missiles were coated with a layer of fibrin. If the foreign body becomes entangled in the chordæ tendineæ, fibrin forms and acts as a basis for a mural clot which generally appears and fixes the object to the endocardium so that it resembles a chrysalis in a cocoon (*Fig.* 573). Foreign bodies which were once free can, in this way, become so sealed off from the general circulation of blood that they may be removed through an incision in the myocardium without hæmorrhage from the interior of the heart. But this fortunate outcome does not always occur for, in the process of encapsulation, thrombi may be shot off into the circulation and these can kill the patient. Two cases will be quoted to show this point. The heart of the first patient, who was a Polish German soldier, is preserved in the Museum of the Royal College of Surgeons of England (*Specimen No.* 659) and I am indebted to Professor Hadfield for the following information: The soldier was wounded in Northern Italy on May 7. The entry wound was an inch behind the middle of the right clavicle. Two days

later about 16 oz. of blood were withdrawn from the right chest; after this convalescence was satisfactory and the wound healed rapidly. But radiographs and screening showed a bullet lodged in the left chest which moved with the pulsation of the heart and was thought to lie behind the left auricle. He was kept in bed with difficulty until June 10 and then allowed up in the ward. There was no clinical or laboratory sign of any irregularity of the heart; no murmurs

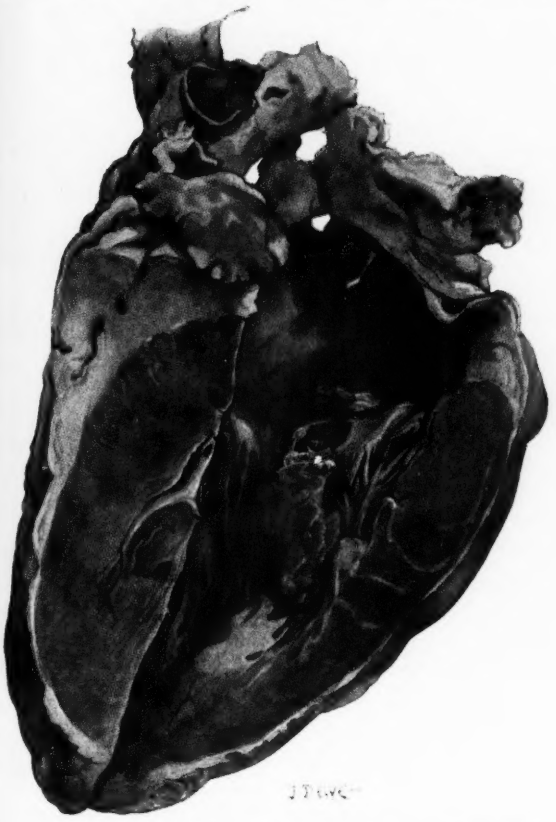

FIG. 573.—Heart showing a bullet held in a mural thrombus immediately below the mitral valve. The patient died from cerebral embolism.

and no symptoms. On June 25 he was standing by his bed when he suddenly felt very tired and became aphasic. He quickly developed a complete right hemiplegia and died on the following day.

At post-mortem the track of the bullet could be traced from the point of entry to the hilum of the lung, through the parietal pericardium high up in the oblique sinus, and into the left auricle between the pulmonary veins. It was not possible to see how it had passed from the hole in the auricle to its final position. All the wounds were healed, but there was the remains of the hæmothorax in the right pleura. The heart contained a bullet, lodged under the posterior mitral cusp, with a clot overlying it. In the museum specimen a small part of the auricular wall has been incised and lifted up to show the base of the bullet; the tip of the bullet is visible in the ventricle (*Fig.* 573). The left middle cerebral artery contained an ante-mortem clot, and the greater part of the left cerebrum was softened.

The second patient was a soldier who was operated upon in 1915 when a bullet was successfully removed from the chamber of the right ventricle. The case was reported by Birkbeck, Lorimer, and Gray (1915). The interesting features were that a few hours after being wounded he became perfectly well and symptomless and remained so for about a week; he was known to have the bullet in his left ventricle all this time. He then developed a sudden sharp pain and ischæmic signs in the leg which were presumably due to an embolus, and it was to prevent further complications that Colonel Gray advised removal of the bullet from the heart. The operation was successful and without special incident, but the patient died four days later and ante-mortem clots were found entangled in the chordæ tendineæ; a long narrow clot was situated in the right pulmonary artery, and there were multiple infarcts in the lungs. The incision which had been made in the heart only four days previously had healed so well that it could scarcely be seen. Harken and Zoll (1946) also mention cases in which clots became embolic from the heart, producing hemiplegia, and they quote the history of the patient, treated by A. D. Nicol, who had a missile lodged in the left ventricle and who became hemiplegic two weeks after the wounding.

Another way in which a foreign body retained in a chamber of the heart might cause serious consequences is by producing a mycotic aneurysm elsewhere; but I have not been able to find a reference in the literature to such a complication. Loison (1899) was one of the first to prove that cardiac aneurysms could occur as a result of heart wounds—he stated that in a series of 254 cases which he had reviewed there were 9 cardiac aneurysms which ruptured some time after the patients had been injured.

The fact that sharp objects such as toothpicks can penetrate the wall of the heart has already been discussed, and the following case-history also reminds us that objects which are not radio-opaque can get into the cardiovascular system either in conjunction with metallic fragments or by themselves. Such foreign bodies are often found to carry in organisms with them and thus to act as starting points for pyæmia or septicæmia.

Lyle (1917) treated a Zouave who had been wounded in the thigh by a fragment of shell; migration of the fragment must have occurred practically immediately, for pre-operative radiographs of the thigh and the abdomen did not reveal the foreign body. The wound in the thigh was laid open four hours after the injury had been sustained and the femoral vessels were found embedded in a mesh of clot, but as far as could be ascertained they were intact. Four days later the patient died of generalized gas gangrene and at autopsy a shell fragment 1·5 × 0·9 × 1·5 cm. (weight 1·81 g.) was found lying free in the cavity of the right ventricle. Pieces of clothing were adherent to the missile and, from these, pyogenic organisms were cultured.

In 1917 Sir Arthur Keith stated that embolism of a bullet from the right ventricle into the pulmonary artery had not been described, but many records of this happening (Harken and Zoll, 1946) are now available for study. These show interesting features which are well exemplified by the following personal case: A sergeant, aged 35, received multiple injuries

in March, 1945, and amongst these a missile passed through a Bible in his tunic and entered the left chest. He was, at first, severely shocked, but his condition improved rapidly under treatment and he was found to have " a rifle bullet in his left lung " (*Fig.* 574).

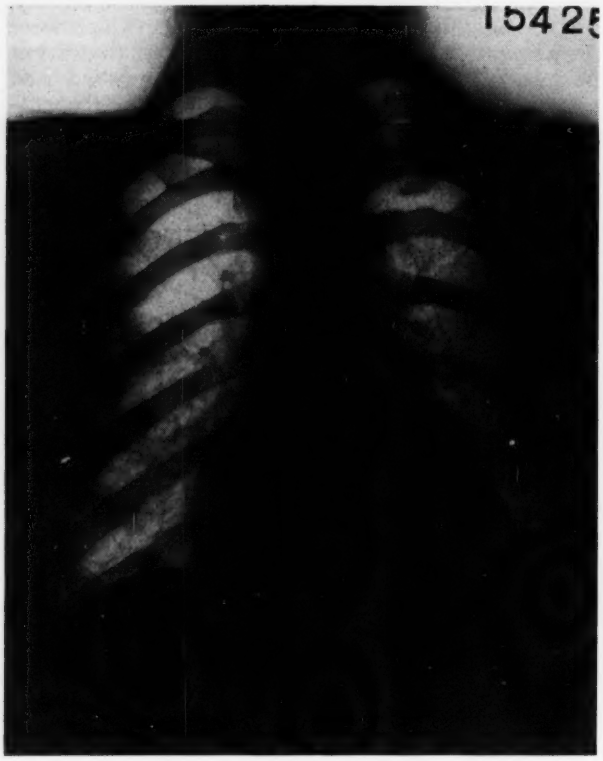

FIG. 574.—This film shows a bullet apparently lying in the left lung and outside the shadow of the heart.

A month later he had arrived at Sully Hospital in Wales and radiographs taken after admission showed the bullet pointing downwards and backwards in the middle part of the left lower lobe. An operation to remove this bullet from the lung was performed by Dillwyn Thomas and the patient was laid in the right lateral position. The left chest was opened in the usual way, and the lung was found to be adherent, but after separation of the adhesions the bullet could be palpated in the lung at some distance from the surface. The lung tissue was incised over the bullet and a profuse hæmorrhage occurred which was difficult to control. When hæmostasis had been secured the foreign body could not be found and the chest was closed. Immediately after this operation radiographs showed the bullet to be " in the opposite lung " and to be lodged in the lower lobe pointing upwards (*Fig.* 575). It was now obvious to us (not only in consideration of the events recorded above, but after bronchoscopy and bronchograms had been made) that it must originally have entered the right side of the heart and that within three days it had passed on as an embolus—but without producing any of the signs of pulmonary embolism—into the left descending pulmonary artery (*Fig.* 576). When the parts were manipulated at operation it was again dislodged and fell, under the influence of gravity, from the left to the right pulmonary artery.

FIG. 575.—This film was taken *after* a left-sided thoracotomy had been performed. The object was to remove the bullet from the left lung, but the operation was unsuccessful because the bullet disappeared. The film shows a hæmopneumothorax on the side of the operation and the bullet to be lying—the other way up— " in the right lung."

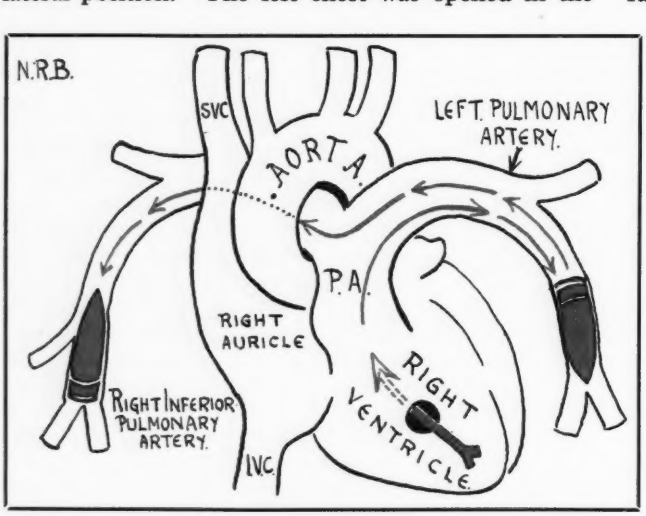

FIG. 576.

Armed with this information and taking care to X-ray the patient immediately before surgical intervention, I operated upon the right side, on this occasion having the patient lying upon his back and opening the front of the chest wall. The bullet was easily removed from the descending branch of the

right pulmonary artery. At this operation the pericardium was found to contain at least a pint of blood-stained liquid which, presumably, was the result of his original wound, but no direct evidence as to the actual point of penetration could be found.

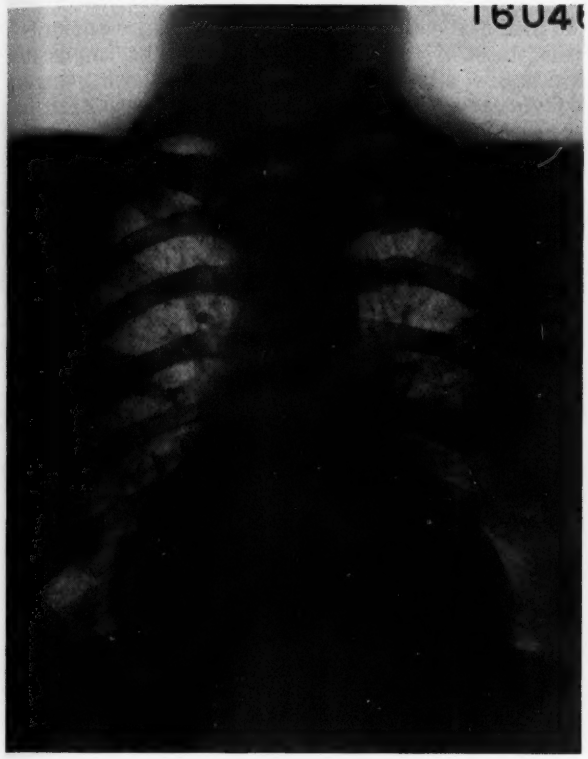

FIG. 577.—Radiograph taken 7 weeks after that shown in *Fig.* 575. The left side of the chest is now restored to normal; the bullet still lies " in the right lung ", but a pericardial effusion has developed and this accounts for the fact that, in this view, the bullet appears to lie within the heart shadow.

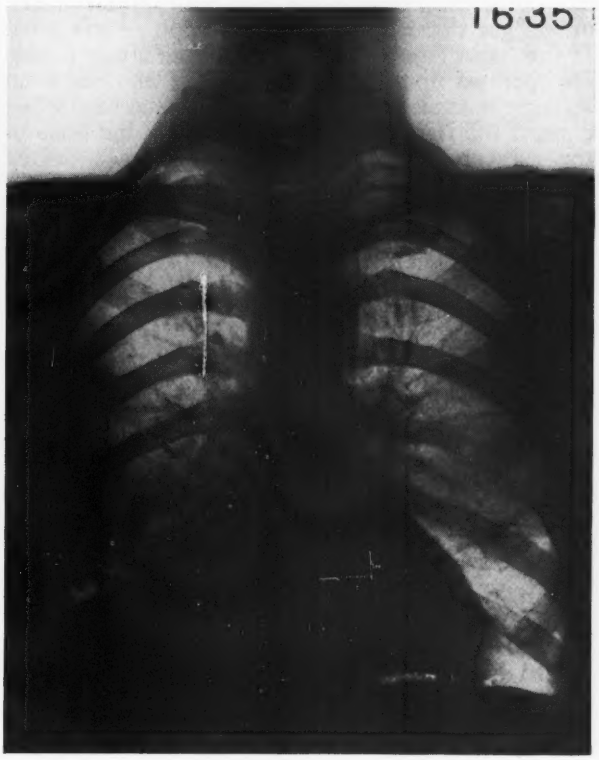

FIG. 578.—Film taken shortly before discharge from the hospital. This patient was seen 2½ years later, and, at that time, his cardiorespiratory system was normal.

The patient made a complete recovery from these operations.

Much confusion has arisen because authors have not distinguished between " fatal pulmonary embolism ", and the effects produced by lodgement of a foreign body in a peripheral branch of the artery in the lung. The two conditions have been treated by many as synonymous. In fact I believe it is true to say that in this whole literature there is no single case of fatal pulmonary embolism caused by impaction of a foreign body in the pulmonary artery or one of its two main branches. The evidence that 'primary' or fatal pulmonary embolism can occur is based upon the oft-quoted opinions of authorities such as Harken and Williams (1946), who do not claim to have seen a case themselves but who state that Paltauf's (1933) patient died of pulmonary embolism. In fact Paltauf's patient was a man, aged 21, wounded by a fragment of metal which entered his main pulmonary artery (at autopsy the vessel was found to have been damaged in the intrapericardial part of its course), migrated immediately to the lower lobe branch of the right descending pulmonary artery, and which caused an abscess in the right lower lobe. According to Paltauf himself the patient died some days later from cardiac tamponade caused by an accumulation of blood in the pericardium. That is, there is no mention of fatal pulmonary embolism in the original paper.

I am aware that large pieces of tumour, such as a hypernephroma, which have grown into the vena cava from the kidney, have sometimes broken off and caused sudden death from pulmonary embolism (Mimpriss and Birt, 1949), but these masses of tissue have impacted in the pulmonary artery itself and not peripherally in the lung, and from the descriptions I have read the emboli were bigger than the foreign bodies which get into the cardiovascular system. It is proper to carry this matter further and to state that, in man, a foreign body which impacts in a peripheral branch of the pulmonary artery rarely causes pulmonary infarction and there is very little danger from ischæmia of the lung. But the clinical picture is different if the embolus is infected. Harken and Williams (1946) reported the story of an American soldier who was wounded on July 15, 1944. Radiographs were taken of the chest two days later and there can be no doubt that at that time there was no foreign body in the lungs. The man was quite well until August 13, when he experienced " an agonizing pain in the lower part of the left side of his chest. This was accompanied by dyspnœa, orthopnœa, cough, and hæmoptysis ". Two days later radiographs showed a bullet in the left lung. An operation was performed on August 28, and the bullet lay in an abscess cavity which included the anterior surface of the lower

branch of the left pulmonary artery. A part of the lingular process of the upper lobe was also gangrenous. The bullet was removed, the abscess cavity and the gangrenous segment were treated appropriately, and the patient was cured.

Apart from foreign bodies which have reached the pulmonary arteries as emboli from the heart, others get there by direct penetration of the lung. Irving Sarot (1949) has described such a case to me. He operated upon a young Hawaiian who had been recently wounded by a fragment of metal which had entered the right chest and lodged " in the hilus of the right lung ". At operation the track of the missile could be traced through the lung and Sarot found the fragment lying inside a branch of the artery. He was able to remove the foreign body without sacrificing either the artery or any part of the lung.

THE TREATMENT OF FOREIGN BODIES RETAINED IN THE HEART

If a foreign body is known to be inside a peripheral vein it should be removed, and the operation is not difficult except in some parts of the venæ cavæ and the cerebral vessels. But since foreign bodies are seldom diagnosed as being inside the lumen of a vein until migration has occurred, and because they hardly ever get into peripheral arteries except from the left ventricle or through the wall of the aorta, treatment of foreign bodies in the cardiovascular system is practically confined to the management of objects lodged in or near to the heart itself.

An object impacted in a branch of the pulmonary artery should also be taken out to avoid late lung complications. The chief technical danger in such an operation is that the surgeon does not realize that the foreign body he proposes to remove is actually inside the lumen of a large artery. To prove this, pre-operatively, can be difficult, but if a cardiac catheter can be passed into the relevant vessel the matter can be solved without doubt. The other risk, at operation, is that a foreign body impacted in one pulmonary artery will fall across the mediastinum into the other lung after the patient has been placed upon the operating table in the lateral position.

Until recently the management of foreign bodies retained in the heart itself has been a matter of individual opinion; but there is reason to believe that, as cardiac surgery improves and as experience accumulates, it will ultimately be possible to state precisely which patients should undergo operation and which should be treated conservatively.

Several surgeons, quoting their own experiences and having reviewed the literature, have attempted to place this matter in its proper perspective, but the opinions of all are subject to the criticisms that their individual chances of observing events have been small and that they have only a limited knowledge as to the ultimate fate of patients treated conservatively. All foreign bodies lodged in the cardiovascular system are potentially dangerous, but there is no way of predicting how a newly embedded missile will ultimately behave, although the case-histories, which have been quoted above, point to the possibilities and indicate the probabilities. About one thing there is general agreement—namely, that the discovery of a foreign body lying in the heart or in one of the great vessels does not in itself constitute an immediate surgical emergency; it is a challenge to stop and think.

The treatment of patients within a few hours of the critical emergency on the one hand, and of those in whom the crisis has passed and only the foreign body remains, on the other, is different. In the first the dice are loaded against success, for the operations must be carried out under difficult or impossible conditions, whereas in the second everything augurs a favourable result. The moment of operation has been chosen, the problem has been considered and a plan evolved, the proper instruments have been made available, and the refinements of technique have been studied. The remarks which follow concern the pros and cons of surgical treatment in these favourable circumstances and attempt to answer the question—" Should a foreign body in the heart be removed? "

Decker (1939) examined the records of 109 patients who had been reported as having foreign bodies lodged in the heart between the years 1900 and 1939. In this series there were 8 deaths following 47 operations (17 per cent), as opposed to 16 deaths in 53 cases treated conservatively (30 per cent). This would seem to indicate an advantage in favour of surgical treatment. As a result of his survey Decker knew that foreign bodies might be infected, and he pointed out that they were a possible cause of " pyrexia of unknown origin ". He noted that, up till 1939, the mortality of operations which had been performed by various surgeons to remove foreign bodies from the heart had been high (15-20 per cent) but that death was not so often directly due to the operation as to subsequent infections. He stressed that craggy and rough pieces of metal were potentially and actually more dangerous than smooth or spherical objects, and he concluded . . . " it may be said that foreign bodies should not be removed simply because of their presence. No emergency exists in those who survive the original trauma, unless one chooses to consider that 'free-cavity' bodies, sharp needle-like bodies, and large objects need early surgery . . . " In 1933 Singleton had expressed similar views—he had collected and reviewed a group of 86 patients who had foreign bodies in their hearts, and he stressed that " an operation may be increasing the danger more than allowing it [i.e., the foreign body] to remain ".

Grey Turner (1941) was another advocate of caution. " A patient who has fortuitously survived a casualty so menacing deserves to be very closely guarded against ill-advised attempts at surgical intervention ", and again, " . . . it would seem to be a good rule to leave the foreign body alone unless the heart continues to rebel against its presence ". This advice, be it noted, was given because Grey Turner was impressed at that time by the immediate dangers of operations upon the heart; he took no account of the serious late complications from which most patients ultimately succumb if treated conservatively.

Tudor Edwards (1944), basing his opinions upon experiences in the first World War, but writing in 1944, stated: " As embolism of the pulmonary artery appeared a probability when the missile was in the right ventricle, prompt action was advised. On the

other hand, as a foreign body in the left ventricle is likely to cause embolism of the subclavian, axillary, or iliac vessels, and its removal from these vessels is less dangerous than removal from the ventricle, it is probably wiser not to operate upon the heart". Experience has shown that this reasoning is open to doubt because embolism from the right heart into a branch of a pulmonary artery generally passes undetected, except to the radiologist, whereas arterial embolism can often be a grave surgical emergency.

As against the men of caution there has been—i.e., since the first World War—a strong band of well-informed surgeons who have repeatedly advocated surgical treatment in practically every case. More than twenty years ago Sauerbruch (1941), Leriche (1916), and Tuffier (1920) stated categorically that all foreign bodies lodged in the heart should be removed. In 1927 Sauerbruch had recorded a series of 105 patients from whose hearts foreign bodies had been taken to control late complications, and the surgical mortality, even at that time, in his hands was 8 per cent. He concurred with Stephens, who stated that, although 95 per cent of people who survive cardiac injuries and who have foreign bodies in their hearts are symptomless at first, only 13 per cent continue to be well indefinitely.

Table II (taken from Decker's paper) summarizes the published results of operations performed to remove foreign bodies from the heart up till 1939

More recent figures have been published by Harken and Zoll (1946), who removed 13 foreign bodies from the chambers of hearts and many more from the myocardium, the pericardium, and the mediastinum. There were no deaths, and it is apparent that these results represent a great advance over the figures quoted by Decker. Harken believes that, in patients who have survived the emergency, foreign bodies should be removed:—

1. To prevent clot breaking away from the foreign body and acting as an embolus
2. To prevent migration of the foreign body out of the heart.
3. To prevent bacterial endocarditis. Harken (1942) had previously shown that foreign bodies introduced into hearts of animals produced "bacterial valvulitis and septic embolic infarcts".
4. To prevent the possibility of progressive myocardial fibrosis.
5. To treat and cure cardiac pain or neurosis.
6. To prevent recurrent pericardial effusions.

Cardiac aneurysm, cerebral complications, and sudden death are other accidents which should be added to this list.

I believe that there is now sufficient evidence available to merit the statement that *foreign bodies lodged in the heart should be removed.* This broad advice must be qualified, but it is important that it be made, for only a few years ago the weight of evidence was in favour of conservative treatment and

Table II.

Author	Year	Number of Cases	Operations Performed	Deaths	Percentage of Mortality	Non-operative Cases	Deaths	Percentage of Mortality
Du Val	1917	39	26	5	20	36	1	3
Escande and Brocq	1917	14	7	3	43	7	1	14·2
De Lorme	1918	25	25	3	12	—	—	—
Le Fort	1918	11	9	1	11	—	—	—
Hoffman	1920	50	15	3	20	—	—	—
Syller	1927	9	8	0	0	—	—	—
Singleton	1933	86	33	4	12·1	49	5	10·2
Decker	1939	100	47	8	17	53	16	30

and shows the wisdom of Matas's opinion that the indications for surgery cannot be formulated by mere statistics.

Since these opinions were expressed another World War has added to our knowledge. We are now armed with antibiotics, anticoagulants, and bacteriostatics; the surgery of the thorax, and in particular the heart, has advanced; and the dangers of operations have been importantly reduced. But let us remember that the experience provided by the second World War was not as extensive as the first—relatively few surgeons got practical work of this type—and let us salute the men who tackled this problem between 1914 and 1918. The results of many operations for removal of foreign bodies from the heart recorded at that time were good and French surgeons in particular deserve mention—Bonneau, Bazy, Raspail (all quoted by Tuffier), Le Fort, and others. In 1918 Le Fort, for example, reported a consecutive series of 9 cardiotomies in which he removed 11 foreign bodies from hearts with a mortality of 1 patient.

the surgeon who operated was considered to be lacking in judgement.

The technical details of how the operations should be done are available in many papers and books (Howard Lilienthal, 1925; Graham, Singer, and Ballon, 1935; Beck, 1926; Horsley and Bigger, 1940), and all emphasize that careful pre-operative planning is necessary and that failures have generally been due to hasty, inaccurate decisions, to poor localization, and to lack of the necessary surgical skill.

In the assessment of any case the following points are relevant. Most surgeons would agree with Samson (1948) that "the only absolute indication for early cardiac surgery in forward hospitals is continuing severe hæmorrhage or immediate cardiac tamponade" and "nearly all intracavitary missiles should be subjected to delayed removal at a base centre". In fact the mere presence of a foreign body in the heart is not important in the emergency; it becomes important if the patient survives. The reasons why it should be taken out come then under

one, or both, of two headings—namely, to relieve cardiac irregularities and pain or to prevent dangerous late complications, and it follows that the experience of the operator must be weighed against these possibilities.

Another consideration is that the longer a foreign body has been in the cardiovascular system the stronger the case for leaving it undisturbed, and this for two reasons—first, the technical difficulty of removal increases as the object gets walled off in scar; and, secondly, the risk of complications decreases as the decades pass. But against this must be placed the statistical fact that missiles acquired in times of war are always more dangerous than those occurring in civil practice.

Clinical reviews by several authors have shown that foreign bodies lodged in the chambers of the heart are potentially more dangerous than those in the myocardium or the pericardium; large objects are more obnoxious than small, mobile ones more dangerous than those held firm, sharp or jagged fragments than smooth, and infected than sterile.

At a recent meeting of the International Society of Surgery (New Orleans, 1949) Evarts Graham remarked that the chambers of the heart were the only remaining surgical frontier. This frontier has been crossed by individual surgeons in many countries; and in experimental animals Crafoord and Bjork (Stockholm), Kolff (Holland), Dennis (Minneapolis), Gibbon (Philadelphia), Leeds (San Francisco), and de Burgh Daly (Edinburgh) have shown that life can be maintained by an extra-corporeal circulation in which the vital functions of the cardiorespiratory systems are maintained by a mechanical heart and lungs. These experiments allow the chambers of the heart to be opened in a relatively dry field; when they can be applied to men and women any remaining doubts as to the wisdom of operations performed upon the heart will have been dispelled.

SUMMARY

These observations are based upon the case-histories and the experiments set out above. They are a framework for further study.

1. The literature abounds in records which include every conceivable type of accident. So varied and so strange are the histories that hundreds of single cases have been described; few are 'unique'.

2. Foreign bodies get into the cardiovascular system in peace as well as in war. My personal experience is of 6 patients—3 civil and 3 war casualties.

3. A great variety of objects have been described. Needles, pins, and bullets are the commonest. Most are small objects and not all are opaque to X rays; clothing, cork, leather, etc., are liable to wrap around jagged metal fragments.

4. A foreign body can get into the *venous system* in several different ways:—

a. The patient may be unaware of any accident or abnormality.

b. Fragments lodged in the liver are prone to enter the hepatic veins or the inferior vena cava.

c. Foreign bodies which penetrate a peripheral vein can enter the lumen and be carried away in the blood-stream.

d. A hypodermic needle or a piece of a catheter may break off inside a vein.

e. A fragment lodged partly inside and partly outside a vein may break adrift and pass into the lumen.

f. Erosion of the wall of a vein can be caused by objects such as radium needles lying adjacent to it.

g. The cardiovascular system has been entered at three sites from the alimentary canal; at the level of the piriform fossa, from the lower end of the œsophagus, and from the third part of the duodenum.

h. Foreign bodies have entered veins from the uterus, the vagina, the bladder, and the bronchial tree.

i. Foreign bodies can also get into the pulmonary artery by direct penetration of the lung.

5. Foreign bodies generally get into *systemic arteries* as emboli from the left side of the heart, but there are records of missiles which have entered the aorta and other large vessels directly.

6. Foreign bodies found *in the heart* generally get there by direct perforation through the thorax; they may be situated in the pericardium, the myocardium, or in a chamber of the heart. An object which migrates from a peripheral vein can come to rest in the right auricle, the right ventricle, or a branch of the pulmonary artery. Foreign bodies in the left side of the heart get there from a direct wound of the heart or of one of the pulmonary veins, by perforating the lower œsophagus, by 'paradoxical embolism' through a patent foramen ovale, or through a patent interventricular septum.

7. In all parts of the cardiovascular system the wound of entry tends to heal so rapidly, unless contaminated, that examination of the tissues after the lapse of a few days reveals no local abnormality. Blood extravasated around a wounded vessel or contained in the pericardium persists longer.

8. Once inside a vein sterile foreign bodies are influenced by forces which are generally opposed. The blood-stream tends to sweep them towards the heart; gravity often pulls in the other direction. Objects which float rise upwards and others sink. 'Migration' and 'retrograde migration' are to be expected. The weight, size, shape, and consistency of an object are also concerned.

9. 'Migration' or 'retrograde migration' may occur at any moment and cannot be prevented except by taking the foreign body out.

10. 'Migration' from a peripheral vein to the heart, or to a branch of one of the pulmonary arteries, is practically always symptomless unless the foreign body carries organisms with it, or unless it perforates the wall of the chamber in which it impacts. The only way in which the movements of such a foreign body can be followed with certainty is by screening and serial radiographs. 'Migration' of a foreign body out of the left ventricle into a systemic artery differs importantly from the silent movement in veins in that ischæmia and gangrene of peripheral parts often occurs. There is no way of predicting which arterial foreign bodies will lodge in one place or which will act as emboli, and the risk of peripheral gangrene—the result of embolism—cannot be foretold.

11. An object carried into the heart along a vein may impact in the right auricle, become entangled in the cusps of a valve, or be held amongst the chordæ tendineæ of the ventricle. It is also likely to lodge in the auricular appendage. If it negotiates these obstacles and travels onwards it impacts in a peripheral branch of the pulmonary artery; such an object, when seen in a radiograph, looks exactly as if it is in the interstitial tissue of the lung, and unless the surgeon is wise to the possibility it will never cross his mind that the missile is in a large artery. A foreign body, like a bullet, impacted in the descending branch of the pulmonary artery does not produce fatal pulmonary embolism or infarction in man. Difficult corners and sharp bends can be negotiated in a way which may seem to be impossible. A foreign body in the right heart may fall back into the caval system; it can sometimes be dislodged from the heart by altering the position of the patient.

12. Foreign bodies in the chambers of the heart —whether they have got there through the chest wall or by migration—can remain mobile and free for at least six to eight weeks. This can be ascertained by fluoroscopy.

13. Once inside the heart some foreign bodies become enveloped in fibrin and shut off from the swirl of the blood like a chrysalis inside a cocoon. The fibrin organizes to form a capsule; such an encysted tumour may remain in situ and harmless for years—on the other hand it may not. A foreign body inside the heart is potentially more dangerous than one in the myocardium.

14. Sharp objects such as hairpins, toothpicks, and wire hair grips, can perforate the heart. Perforation can occur without suppuration, but is generally fatal. Partial perforation is a cause of recurrent pericardial effusions.

15. Foreign bodies inside the cardiovascular system may have carried organisms in with them. Even so they may be symptomless for some time or may give rise to a 'pyrexia of unknown origin'. Pyæmia, septicæmia, or abscess may occur and embolic abscesses will not necessarily be at the same place as the foreign body which has caused them.

16. Foreign bodies in the heart can cause a variety of symptoms including arrhythmias, pain, neurosis, dyspnœa, sudden death. They may be the cause of cardiac aneurysm, embolism, thrombosis, progressive myocardial fibrosis, pericardial effusions, hæmorrhage from perforation, cerebral complications, etc. On the other hand they may cause no apparent harm.

17. In some patients symptoms and complications are present from the first, in others they come on at any time up to thirty years or later. In all they are more likely than not to occur ultimately.

18. It may be difficult or impossible—without surgical exploration—to say whether a foreign body lies in the cardiovascular system or not.

19. A foreign body lodged in the cardiovascular system is always a potential danger to life—wherever it is it should be taken out whenever possible. In practice this resolves itself into the treatment of foreign bodies lodged in the heart, in a branch of one of the pulmonary arteries, or suddenly impacted in a peripheral artery and producing ischæmia of a limb. If there is no special difficulty or problem in connexion with the two latter possibilities the foreign bodies must be removed; but argument still ranges about the proper way to treat foreign bodies retained in the heart itself. The technical details of the operations which may have to be performed have been so far perfected that the onus is now upon the surgeon to say why a particular object should not be taken out of the heart rather than why an operation should be advised.

20. There are three clinical phases in the history of these patients in which a decision must be taken. In the emergency the concern is to save life and the presence of a foreign body in the heart is of secondary importance. During the period of convalescence and shortly after, the decision to operate depends upon the belief that late complications can be avoided or that limitations of cardiac function can be ameliorated without exposing the patient to mortal hazard. Patients who have harboured a foreign body in the heart for years without apparent harm will not want it removed, but they may come to the surgeon when complications occur; some of these late complications can still be relieved by removal of the foreign body, but others are by now beyond surgical cure.

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(I.e., To foreign bodies retained in the heart for a long time without causing apparent harm.)

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THE NATURAL HISTORY OF CAROTID BODY TUMOURS AND THEIR DIAGNOSIS AND TREATMENT

WITH A REPORT OF FIVE CASES

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From a study of the literature concerning carotid body tumours it is apparent that there still exists considerable confusion as to the salient features in their diagnosis, and even greater controversy as to the best lines of treatment.

The concept of the pathology and behaviour of carotid body tumours which has resulted from this same study, and from a study of pathological material and records of 5 hitherto unreported cases, has, however, led to the crystallization of a number of ideas on diagnosis and treatment which, incorporating recent advances in ancillary branches of surgery, have been embodied to form a comprehensive scheme of management. This scheme of management, together with the account of the natural history of carotid body tumours on which it is based, forms the substance of this contribution.

THE NATURAL HISTORY OF CAROTID BODY TUMOURS

In addition to the 5 cases already mentioned in which there was direct access to clinical and pathological material, this account is based on a survey of 223 cases drawn from the literature and acceptable as carotid body tumours.

Age Incidence.—The average age at which a tumour was first noticed in 174 cases in which age and duration of symptoms could be traced was 34 years, but the age of onset extended over a wide range. The youngest was recorded by very Wosnessenski (Gordon-Taylor, 1940), and occurred in a child aged six months. Another was recorded at the age of 5 years (Green, 1908). The oldest recorded was in a man of 76 years (Smoot, 1947).

Sex Incidence.—There is no striking predilection for either sex. Of 206 cases reviewed in which the sex was recorded, 106 tumours occurred in men, 100 in women. It is, however, interesting to note that of 21 cases of malignant carotid body tumour 15 occurred in men and only 6 in women.

Duration of History.—Carotid body tumours have a reputation for slow growth; in 174 cases specifying duration of symptoms prior to seeking medical attention the average duration was seven years. The shortest recorded history was six weeks (Callison and MacKenty, 1913), whilst there were numerous examples of histories of less than three months' duration. The longest recorded history was thirty-seven years (Von Heinleth, 1900).

Family History.—No aid in diagnosis can be expected from the family history. Incidence in closely related persons is of such rarity as to be a curiosity. In the 223 cases reviewed there were only 2 instances of familial occurrence (Burge, 1916; Chase, 1933).

Multiple Tumours.—Carotid body tumours are usually solitary, but by no means invariably. Bilateral origin from the carotid bodies has been claimed in 9 instances. The case described by Middleton and Bierring (Keene and Funke, 1906), the authenticity of which was vouched for by Paltauf (1892), at that time one of the greatest authorities on the subject, should be recognized as the first recorded instance of bilateral tumour.

Two tumours of carotid body type occurring simultaneously, but on the same side, have also been described by Kipkie (1947). In this instance a carotid body tumour, normally situated, was associated with a similar tumour in the middle ear, presenting as an aural polyp, and presumed to arise from the homologous glomus jugulare of Guild (1941).

Malignancy.—The very occurrence of malignancy is considered by some a distinct bar to the diagnosis of carotid body tumour (Phelps, Case, and Snyder, 1937; and Leclerc and Dubard, 1926), even to the point of asserting that to establish the identity of a suspected carotid body tumour necropsy is essential to exclude a possible primary elsewhere (Willis, 1948). The question of malignancy is a matter of the utmost importance in considering treatment, and is therefore dealt with in detail.

A careful study of the literature combined with a consideration of the histological material from the cases presented in this paper has led to the elimination of many claims to malignancy, principally those where the diagnosis was made solely on histological appearances, a matter which is discussed more fully in a subsequent paragraph. Some further cases which have been claimed as malignant carotid body tumours have also been excluded, their origin from the carotid body rather than their malignant nature being in doubt (Gilford and Davis, 1904; and Coley, quoted by Callison and MacKenty, 1913).

In the absence of any certain histological criterion, malignancy has been assessed on the clinical basis of metastasis or recurrence following operation, and in estimating the incidence of malignancy it has therefore been necessary to exclude all operative fatalities. One hundred and seventy-nine cases of carotid body tumour either survived operation or received no treatment, and of these 21 developed recurrence or metastasis, an incidence of malignancy of 12 per cent.

Comment has already been made on the preponderance of males in malignant cases. In respect of age incidence and duration of symptoms there appears little difference in behaviour between malignant and benign tumours. The average duration of symptoms is five years, and though shorter histories are the more common, in one instance the history extended over thirty years (Lilienthal, 1909).

The majority of carotid body tumours are somewhat adherent to their surroundings, and in all probability exhibit a restricted degree of local infiltration. The commonest overt malignant manifestation is local recurrence following local excision, and such recurrence has usually proved fatal. There have, however, also been instances of glandular metastases, the authenticity of which seems beyond reasonable doubt (Kopfstein, 1895; and MacComb, 1948), and a number of instances of alleged blood-borne metastases which are considered in greater detail, since this is an aspect of the subject which appears controversial.

Mönckeberg in 1905 reported the case of a woman from whom a carotid body tumour was successfully removed. Four years later, however, the woman died following removal of an ovarian tumour. In some reviews this seems to have been taken as an instance of metastatic carotid body tumour. This was not, however, the case; Mönckeberg made no such claim, and described the ovarian tumour as a simple papillary cystadenoma.

Gilford and Davis (1904) described a post-mortem case of bilateral cervical tumours associated with diffuse hepatic carcinomatous infiltration which they interpreted as a case of malignant carotid body tumour. It appears, however, that this deduction was almost certainly incorrect, since these authors' general impression of the character of carotid body tumours appears to have been that they are highly malignant. Furthermore, the relation of the cervical tumours they described to the carotid bifurcations does not seem to have been particularly intimate.

More recently cases have been described in which the genuineness of the metastasing carotid body tumour has been more convincing.

The case described by Donald and Crile (1948) where simple excision of a carotid body tumour was followed fourteen years later by the development of a vertebral metastasis, and eleven years later still by multiple bony metastases, is very convincing.

A case has been described by Prendergrass and Kirsh (1947) of a tumour of the carotid bifurcation for which ligature of the common carotid artery was carried out under the impression that the tumour was an aneurysm. This was later followed by multiple metastases in bones, lungs, and liver; post-mortem showed a typical carotid body tumour and metastases with similar histology.

Finally a case described by Grönberger (1917) of a cervical tumour spreading to the mediastinum and being found post mortem to have a renal metastasis also appears genuine, though slightly less convincing than the preceding 2 cases, by reason of the less determinate relationship of the cervical tumour to the carotid bifurcation.

Nevertheless there seem very reasonable grounds for believing that blood-borne metastasis from a carotid body tumour can occur.

Situation.—The situation of a carotid body tumour is one of its most characteristic features. Essentially it lies between and embracing the carotid vessels at the bifurcation. This intimate relationship can often be appreciated clinically, and in particular the external carotid traced over the anterior aspect of the tumour, constituting one of the most important points in diagnosis.

Anatomical variation of the carotid body, however, allows of slight variation in the intimacy of the relationship of its tumours to the bifurcation, whilst the occurrence of tumours similar to the carotid body, but in situations remote from the bifurcation, can be explained on grounds of embryological homology. The whole question of ectopic tumours is, however, dealt with at greater length in a subsequent paragraph, and it suffices to say here that, as a general rule, any tumour for which a diagnosis of carotid body tumour is put forward, which has not a most intimate relationship with the bifurcation, is at once highly suspect, whilst any tumour embraced by and embracing the bifurcation derives almost certainly from the carotid body.

Consistency.—It must be emphasized that carotid body tumours vary considerably in structure and consequently in consistency. They may be fibrous and hard, or on the other hand, vascular, cavernous, and extremely soft. The former type may be quite devoid of pulsation, even transmitted, the latter may show true expansile pulsation, which may be of the type first recognized by Reclus and Chevassu (1903), where firm compression leads to an almost complete disappearance of the tumour, which reappears on release of pressure in a series of pulsations. Variation in fixity is also encountered, but in general lateral movement in the neck alone is possible.

It is unfortunate that the term ' potato tumour ' has become associated with tumours of the carotid body, for it appears to be a name which, whilst appealing to the imagination and memory, may lead to errors of diagnosis by creating a biased impression as to the invariable hardness of these tumours. It is also interesting to note that its association with carotid body tumours probably arose in error. It was originally applied by Jonathan Hutchinson (1888) to describe the occasional occurrence of a type of cervical tumour, highly malignant, fungating through the skin in a few months, and causing rapid death. Hutchinson himself did not associate his ' potato tumours ' with the carotid body—" In several cases portions removed for microscopic examination have been pronounced ' round-celled sarcoma, or lymphosarcoma ' "—the association was made some years later by Gilford and Davis (1904), and was based almost certainly on an error of diagnosis.

Histology.—Just as there is a wide variation in the gross structure of carotid body tumours, so also marked variations in microscopical anatomy occur. Nevertheless, the final diagnosis of a carotid body tumour rests on its histological appearance, even though this appearance is varied, and is more easily recognized than described.

In general, carotid body tumours are cellular and vascular tumours. The cells are of moderate size, polygonal or tending to spindle shape, having finely granular faintly acidophilic cytoplasm, and a rather vesicular nucleus with fairly prominent chromatin network and nucleolus. The cells tend to be aggregated in clumps and strands, intersected by numerous large capillary spaces, many of which have a complete endothelial lining, though in places the principal cellular elements appear to be in direct contact with the blood.

The parenchymal cells may appear to be aggregated in radial fashion around the vascular spaces, giving a ' peritheliomatous ' appearance. Alternatively, cell clumps may appear contained in the vascular spaces, the alveolar type. Yet other cells may take on more pronounced spindle-shaped and branched forms, and form a diffuse sheet of branching strands intersected by the vascular spaces, the reticular type. In others again the vascular spaces are enlarged to give a cavernous appearance. Finally, there may be an extreme variation in the parenchymal cell, scattered cells occurring of unusual size, exhibiting more intensely staining cytoplasm and nuclei, and even multiple nuclei.

In the majority of tumours the stroma is intersected by numerous fibrous trabeculæ usually containing vessels of considerable size. In a minority this fibrous development may be extreme, the tumour in the main consisting of fibrous tissue containing only sparsely scattered islets of cellular and vascular elements. Such fibrous types are particularly prone to myxomatous and degenerative changes and even to calcification.

Such considerable cellular variation, lacking as it does any outstanding associated difference in tumour behaviour, makes the accurate histological prognostication of malignancy impossible.

Some observers (Kohn, 1900) have described as a specific staining reaction in carotid body tumours, the appearance of cytoplasmic granules staining deep brown with chrome stains, such as is exhibited by the adrenal medulla. Little diagnostic importance, however, can be attached to this inconstant and imperfect exhibition of chromaffinity.

Ectopic Tumours.—Although emphasis has been laid on the constancy and intimacy of relationship of carotid body tumours to the carotid bifurcation, such relationship is not invariable. A carotid body tumour may arise at a level as low as the lower border of the thyroid cartilage (Rössing, 1934) or may present in the posterior triangle of the neck rather than in the anterior, as in *Case* 5 in this paper. Such variations are explicable on the basis of the minor anatomical variations in situation of the carotid body which are known to occur (Paunz, 1923; Adachi, 1928).

Tumours having a histological structure identical with carotid body tumours may, however, occur in situations more remote from the carotid bifurcation —namely, in the petrous temporal (Rosenwasser, 1945; Kipkie, 1947), and in the superior mediastinum (Bloom, 1943; Monro, 1950). Such are not true carotid body tumours, but tumours of the homologous glomera which occur in those situations, namely, the glomus jugulare (Guild, 1941), in the petrous temporal, and the aortic and pulmonary

glomera in the mediastinum (Nonidez, 1936 and 1937). Carotid, aortic, and pulmonary glomera derive from the walls of the third, fourth, and sixth branchial arch arteries (Boyd, 1937 and 1939), an embryological feature which seems in keeping with the physiological observation that these glomera are concerned with the control of respiration (Dripps and Comroe, 1944), a function primitively mediated by the branchial arches. Though a comparable origin has not yet been established for the glomus jugulare it is probable that it arises from the second arch artery, a remnant of which persists as the stapedial artery.

That tumours identical with carotid body tumours should arise from the homologous glomera of other branchial arches is to be expected, but it must be recognized that these are not strictly speaking carotid body tumours, but rather that carotid body tumours are one form of branchial glomus tumour (Monro, 1950).

THE DIAGNOSIS AND TREATMENT OF CAROTID BODY TUMOURS

DIAGNOSIS

The diagnosis of carotid body tumour should be entertained when any solitary tumour is found below and adjacent to the angle of the jaw, particularly if there is marked pulsation. Such pulsation may be transmitted or expansile, and if the latter, firm compression may lead to reduction in size, with re-expansion on release of pressure in a series of pulsations. (Reclus and Chevassu, 1903.) The consistency of such tumours is soft. In hard tumours pulsation when present will be transmitted. The variation in consistency of these tumours is not surprising in view of their very varied histology and vascularization, but it should be pointed out that there should be no confusion in differentiating these tumours from a branchial cyst (as occurred through ignorance of the variations which carotid body tumours may exhibit, in *Case* 5), for if the tumour feels cystic then expansile pulsation must be demonstrable, it must be the angiomatous type, whilst if the tumour feels solid it cannot be confused with a branchial cyst.

An exceedingly important point is the exact relationship of the carotid vessels to the tumour.* It is commonly possible to trace the vessels as they embrace the tumour, the internal carotid posteriorly and the external anteriorly. It is the only tumour of this region in which a large vessel can be felt pulsating in front of the tumour. So diagnostic is this sign that it was possible in one instance (*Case* 4) to make a confident and correct pre-operative diagnosis in a case where all other evidence pointed to a recurrence of glandular metastases secondary to a carcinoma of the tongue. Such is the normal topography and such the vascular relationship in the majority of instances, but occasionally the tumour is situated at a slight distance from the bifurcation. In such ectopic cases the diagnosis is obviously rendered more difficult.

Aspiration has been carried out on carotid body tumours, usually the angiomatous type, under the impression that the swelling was a branchial cyst or cold abscess (as occurred in *Case* 5). It results in the withdrawal of blood, and apparently causes no harm, but as a means of differentiating the soft carotid body tumour from cystic lesions aspiration should be unnecessary, pulsation allowing differentiation.

Punch biopsy has been advocated and practised by some authors (MacComb, 1948). It appears, however, to give a high proportion of negative results, apart from which its use would seem to be unjustifiably risky when dealing with a tumour of such exceptional vascularity and where the possibility of aneurysm cannot always be excluded (Lahey and Warren, 1947). If it were possible from such a biopsy to distinguish benign from malignant tumours of the carotid body then it would be a procedure of greater value, but such is not possible, and by comparison with a controlled formal biopsy this technique appears to have nothing to recommend it. There is no doubt, however, that any provisional diagnosis of carotid body tumour should be confirmed by biopsy, for the issues at stake in treating such a tumour are too grave to allow of any uncertainty. (Lahey and Warren, 1947.)

Arteriography has been suggested as a technique of value in these tumours: on the one hand, as a means of estimating the intimacy of adherence of the tumour to the great vessels, allowing distinction prior to operation of those cases in which a simple excision should be feasible, and on the other hand, as a method of outlining the circle of Willis and predicting the adequacy of collateral circulation should carotid resection be required. It is certain that the former distinction cannot be made (Enderlen, 1938), whilst a much better estimate of the collateral circulation is obtained by a functional rather than an anatomical assessment, employing the method to be described later. Arteriography would appear to play no part in carotid body tumour diagnosis unless it be in the occasional case where the possibility of aneurysm cannot be excluded on clinical grounds.

Carotid sinus syncope is in no way a diagnostic feature of these tumours, indeed the rarity of the association is perhaps remarkable. Furthermore, in only one instance of all carotid body tumours described has there been a syncopal attack during operation (Migniniac, 1937). It appears that the reflex is abolished under general anæsthesia (McSwaine and Spencer, 1947).

Summary.—The first step to diagnosis of a carotid body tumour is to think of it. The diagnosis will be more readily suggested if there is pulsation, and is made almost certain if the tumour can be felt to be embraced by the carotid bifurcation.

TREATMENT

Seeing that it is unlikely that any one surgeon will encounter more than one or two of these tumours in the course of his career, it is essential that benefiting from the experience of others he should have a clear plan of procedure in assessing these cases, and a plan of treatment to cover all eventualities.

In view of the considerable overall operative mortality of 15 per cent which has been experienced in the past, and considering the relatively slow growth of the majority of these lesions, and the comparative

* Mr. R. Vaughan Hudson, personal communication.

absence of symptoms other than the presence of an unsightly swelling in the neck, it may well be asked whether there is any real indication for operation at all.

If it could be assumed that carotid body tumours are benign, then such an operative mortality would prohibit an operation undertaken only for minor symptomatic relief. Such an assumption is, however, unjustifiable. Malignant tumours do occur, an incidence of 12 per cent being found in the cases reviewed. Even so, operation would still be unjustifiable unless it could be shown to check malignant infiltration and to be followed by an increased expectation of life.

Death directly attributable to the progressive growth of a carotid body tumour in cases either explored and abandoned, or treated by inadequate operation such as curettage, or left entirely untreated, has occurred in 30 per cent of such cases. By contrast, where radical operative treatment has been carried out, the subsequent death-rate attributable to recurrence is much diminished, being 7·5 per cent in the case of tumours removed by dissection, with conservation of the carotid bifurcation, and only 3 per cent in cases where tumour and bifurcation have been resected *en bloc*. The number of cases considered in each group is of necessity small, the follow-up histories being pathetically inadequate, yet, nevertheless, the figures appear consistent and to imply a significant advantage to be gained from operation.

The advantage conferred by operation must, however, be offset against the mortality. In cases treated by removal by dissection there is a mortality of only 6·5 per cent, and there would therefore appear to be a sound case for exploration and attempted simple excision in all cases. In cases, however, where there has been resort to carotid resection there is a mortality of 29 per cent and there would appear to be no grounds whatever for choice of this procedure as a routine, all the more so as it provides little greater security against recurrence than the less radical procedure.

That this view has become increasingly prevalent is at once apparent from a perusal of any of the more recent reviews, and more particularly from that by Phelps, Case, and Snyder (1937), who have computed the proportion of cases in which resection was deemed advisable at different stages in the development of the treatment of these tumours as follows :—

Period	*Percentage of Bifurcation Resections*
1880–1920	82 per cent
1920–1928	64 per cent
1929–1936	50 per cent

The incidence of carotid resection in the cases here reviewed is only 40 per cent.

It seems likely that an increasing respect for the integrity of the carotid vessels, combined with an increasing determination to define wherever possible the white line of cleavage in the adventitia described by Sir Gordon Gordon-Taylor (1940), will lead to the successful removal of an increasing number of carotid body tumours without interference with the carotid bifurcation. Nevertheless, it is also likely that in a proportion of cases removal of the tumour will still necessitate carotid resection, in which circumstances the advisability of proceeding with the operation may be doubted, and is a matter that must be considered further.

The operative mortality of 29 per cent associated with carotid resection would appear at first sight prohibitive, but it becomes less of a deterrent when it is reflected that abandoned operations are eventually fatal in 30 per cent of cases. Furthermore, it seems likely that it is the comparative innocence of some carotid body tumours which allows of their simple excision, whilst by contrast the very adherence of others is an indication of malignancy, and demands their removal, even at the cost of sacrificing the carotid bifurcation. Finally, there is every reason to suppose that the mortality for carotid resection in the past is not the best that can be anticipated. The more general adoption of pre-operative assessment of the functional reserve of the carotid collateral circulation, combined with routine pre-operative partial carotid occlusion to increase this reserve, and when necessary the use of a free vein graft to restore carotid continuity, should do much to lessen the incidence of ischæmic fatalities following carotid resection.

The method described by Matas (1934) for the recognition of patients who will develop hemiplegia following carotid ligature consists in the compression of the common carotid against Chassaignac's tubercle, and observing whether any faintness ensues. This certainly demonstrates those cases where the collateral circulation is grossly inadequate, but faintness cannot be taken as a very sensitive index of disturbance of the cerebral circulation. Lambert Rogers (1947), dealing with intracranial aneurysms, has advocated more exact investigation of this point by temporary occlusion of the common or internal carotid, exposed under local anæsthesia, with simultaneous electroencephalography, combined with comparison of muscular function on the two sides by use of the dynamometer. This method gives objective evidence of slighter degrees of impairment of cerebral function resulting from ischæmia, and should be adopted for the selection of cases to be treated by ligature. This technique has already been employed by Goldberg (1947) in the investigation of a case of carotid body tumour, but he was more concerned to study the effects of an associated carotid sinus syncope than to assess the carotid collateral circulation.

Pre-operative Preparation of the Collateral Circulation.—Neither the Matas test nor Lambert Rogers's method can give a certain prediction that hemiplegia will not follow internal carotid ligation (Rogers, 1944; Lahey and Warren, 1947). One reason is that with either test, in cases of carotid body tumour, the preliminary occlusion must be of the common carotid artery, whilst the impairment of cerebral circulation following occlusion of the internal carotid is much greater (Rogers, 1947). Every effort should, therefore, be made to improve the collateral circulation prior to operation even in those cases which appear to tolerate preliminary common carotid occlusion.

The collateral circulation can be increased by periodic compression of the common carotid (Matas, 1934), but an even more effective method is that devised by Dandy (1942), who, also in connexion

with ligature of the internal carotid for intracranial aneurysm, has advocated preliminary partial occlusion of the common carotid by a ligature tied over a fascial strip designed to prevent damage to the intima.

Reviewing the results of direct internal carotid ligature for intracranial aneurysm, Dandy found published mortalities ranging from 30 per cent to 50 per cent. In his series of 88 cases in which he carried out preliminary partial ligature of the common carotid he found a mortality of only 4·5 per cent.

A similar improvement is to be anticipated from the general application of this principle to cases of carotid body tumour.

Vascular Anastomosis.—The technique of replacement of arterial defects by venous graft (Blakemore, Lord, and Stefko, 1942, 1943) has been perfected to such a point that, in the experimental animal even a small-calibre vessel, such as the femoral artery of a dog, can be resected and replaced with a venous graft with a successful outcome in 90 per cent of operations, whilst in the larger vessels, such as the aorta, success can be anticipated in almost every instance. This expectation would appear even more justifiable in the still larger human carotid, and is an operation which has already yielded satisfactory results in the case of the human popliteal artery. In view of the technical difficulties involved and the excellent results which should be obtained by simple ligature combined with suitable pre-operative treatment in cases having an adequate carotid collateral circulation, it would appear unnecessary to carry out an anastomosis in all cases where carotid resection is performed, but rather to reserve this technique for those cases requiring resection where an inadequate collateral circulation has been demonstrated. In all such cases, however, the same pre-operative routine of preliminary partial carotid occlusion should be followed, for fear that, at operation, extension of the tumour toward the base of the skull may be found to have occurred, leaving available so short a distal carotid stump as to preclude anastomosis and render ligation obligatory.

It is interesting to note that over thirty years ago a resection of the carotid bifurcation with successful end-to-end suture anastomosis of common and internal carotids was carried out when removing a carotid body tumour (Enderlen, 1938).

Post-operative Care.—In some cases following carotid ligature, the pressure in the collateral circulation is sufficient to maintain cerebral function when the patient is supine, but inadequate if the patient sits up, syncope resulting (Schorstein, 1940). Cases which have undergone carotid ligature should therefore be nursed flat for the first few days following operation, with the foot of the bed raised on blocks.

It is now also recognized that hemiplegia following carotid ligation may be a delayed phenomenon (Rogers, 1944, 1947). Delayed hemiplegia may result from embolism from the blind internal carotid stump, but more often occurs as a result of extension of thrombosis from the stump. Delayed hemiplegia has also been known to follow simple excision of a carotid body tumour without carotid resection (Lahey and Warren, 1947), thrombosis being due to trauma to the vessel wall occurring during the tedious dissection. The danger of thrombosis occurring at the site of any vascular anastomosis is too well known to need further comment. Anticoagulants should, therefore, be administered post-operatively whatever type of operative procedure has been adopted for removal of a carotid body tumour (MacComb, 1948).

Radiotherapy.—A word should be added on the subject of resort to radiotherapy. Radiotherapy has proved effective in a few cases, but in so small a number as to exclude its use as a treatment of choice, and to render its routine use as an adjuvant to surgery unjustifiable. Radiotherapy should be restricted to those refusing operation, or to inoperable cases.

Summary of Management.—Treatment is operative. It is essential to perform a biopsy by direct exposure of the tumour. This is best carried out under general anæsthesia, in part because considerable hæmorrhage may be encountered and may be difficult to control, and also because under local anæsthesia there may not be an abolition of the sinus reflex, and it would appear that direct interference with the tumour in such circumstances might lead to embarrassing sinus syncope.

The diagnosis established, the carotid collateral circulation should be investigated by digital occlusion of the common carotid and by temporary ligation or clamping of the same vessel exposed under local anæsthesia, combined with electro-encephalography. At the completion of this investigation the common carotid should be partially occluded to augment the cerebral collateral circulation.

The final operation is undertaken after a suitable interval to allow development of the collateral circulation, and wherever possible the tumour is removed by simple dissection, the carotid vessels being preserved.

Where this is impossible, removal is accomplished with resection of the carotid bifurcation, the vessels being ligated if pre-operative investigation has shown a good collateral circulation, but an anastomosis by vein graft of common and internal carotid stumps being carried out if investigation has shown the collateral circulation to be inadequate. If, however, the stump of the internal carotid remaining at the base of the skull is too short to allow of anastomosis, ligature is carried out even though the collateral circulation may have appeared inadequate in the original occlusion test, for the partial ligature of the carotid performed pre-operatively will have given a margin of safety sufficient to warrant taking this risk. Post-operatively all cases of resection and ligature should be nursed recumbent with the foot of the bed on blocks, and blood-coagulability should be reduced by giving heparin. Should operation be refused, or the tumour be inoperable by reason of extension to skull or mediastinum, radiotherapy should be given a trial, and may achieve a rare success.

CASE REPORTS

Case 1.—E. A., a woman of 35 years, was admitted to Savernake Hospital with a diagnosis of congenital heart disease and ' glands ' of the neck.

The ' gland ' was removed and submitted for histological examination. It showed a carotid body tumour

highly vascular and cellular, the parenchymal elements having a peritheliomatous arrangement (*Fig.* 579).

The patient died ten years later without evidence of recurrence.

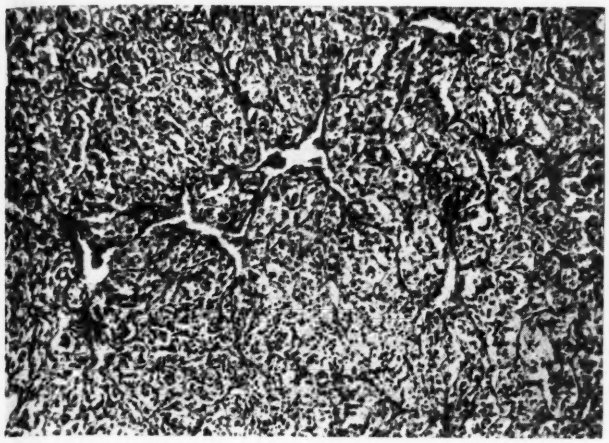

FIG. 579.—*Case* 1. Section from carotid body tumour, showing 'peritheliomatous' arrangement characteristic of some of these tumours. (× 60.)

Case 2.—S. M., a man of 33 years, attended Middlesex Hospital for a lump in the right side of his neck which had been present for ten years. During that time he had had two explorations and a course of radiotherapy without benefit.

He presented a moderately soft irregular tumour lying in the carotid bifurcation, the main vessels being clearly palpable anterior and posterior to it. The diagnosis of carotid body tumour was made (R. Vaughan Hudson).

A preliminary ligature of the external carotid was performed and subsequently the tumour removed, though perforation of the internal carotid during dissection necessitated ligature of all the main vessels.

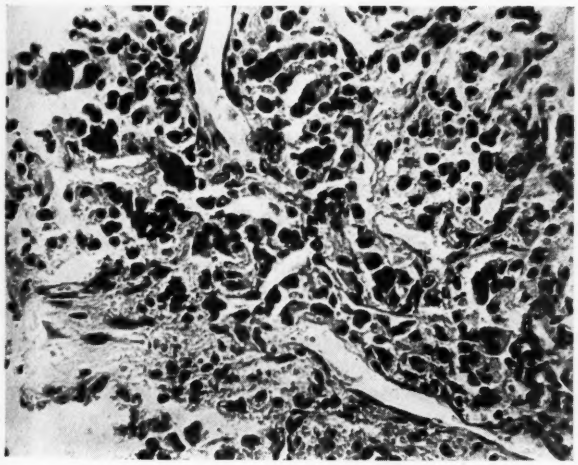

FIG. 580.—*Case* 2. Section from carotid body tumour illustrating typical vascularization and the cellular pleomorphism with giant and multinucleate cells not uncommonly found in these tumours. (× 190.)

Histological examination showed a highly cellular and vascular tissue with considerable variation in cell type, including mononuclear and multinuclear giant cells. The appearances were those of an alveolar type of carotid body tumour (*Fig.* 580).

There has been no recurrence for five years.

Case 3.—C. B., a woman of 47 years, was admitted to the Bolingbroke Hospital for an enlarged gland in the right side of the neck which had been noticed for six months. It appeared hard and somewhat fixed and was

FIG. 581.—*Case* 3. Section from carotid body tumour illustrating a reticular type of tumour with considerable fibrosis and hyalinization. (× 48.)

explored on a diagnosis of tuberculous adenitis. With difficulty and much bleeding it was detached from the carotid vessels and transverse process of the atlas, to which it was very adherent.

The patient made a good recovery.

Histological examination showed a vascular reticular type of carotid body tumour with areas of fibrosis and hyalinization (*Fig.* 581).

Case 4.—A. O., a housewife, aged 64 years, was admitted to Middlesex Hospital in 1932 for interstitial radium implantation for an early carcinoma of the tongue. This was followed by block dissection of the left side of the neck. Two years later, in view of

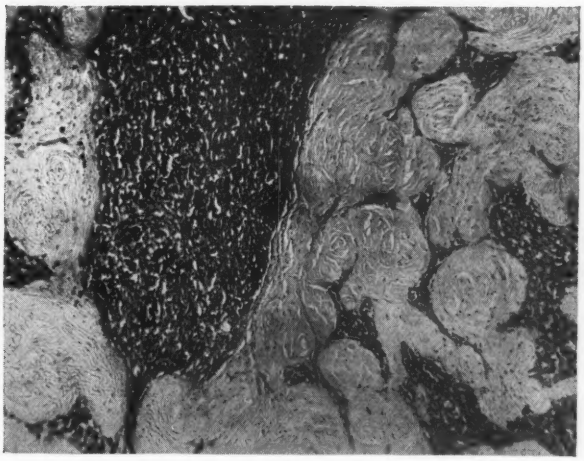

FIG. 582.—*Case* 4. Section from carotid body tumour, showing areas of extreme cellularity and other areas of marked fibrosis. (× 36.)

recurrent leukoplakia, a left hemiglossectomy was performed. There was no further sign of trouble until 1948 when 'a firm gland' became palpable behind the angle of the jaw on the side of the block dissection. Initially thought to be a recurrence, the opinion was subsequently expressed by Mr. R. Vaughan Hudson

that this was a carotid body tumour, since the external and internal carotids were readily palpable embracing the 'gland'. Operation was carried out on this diagnosis, and the tumour dissected with difficulty from between the vessels at the bifurcation. Histological examination showed a carotid body tumour exhibiting a mainly fibrous basis, but incorporating vascular and cellular areas of typical appearance (*Fig.* 582). These

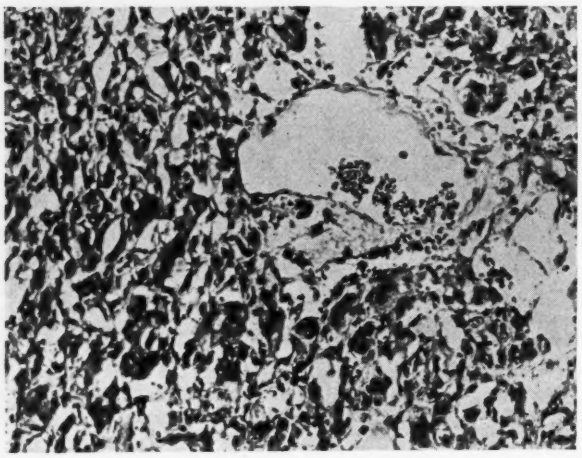

FIG. 583.—From the same case, again illustrating cellular pleomorphism and giant cells. (× 150.)

areas were, however, in places remarkable for scattered large mono- and multi-nuclear giant cells, a recognized feature of some carotid body tumours (*Fig.* 583).

Case 5.—J. P., a housewife of 43 years, was admitted to Middlesex Hospital complaining of a lump behind her right ear, noticed for a year, and slowly increasing in size.

The tumour was 5 cm. in diameter, lay below the mastoid process, deep to the sternomastoid, and projected slightly into the posterior triangle. It appeared

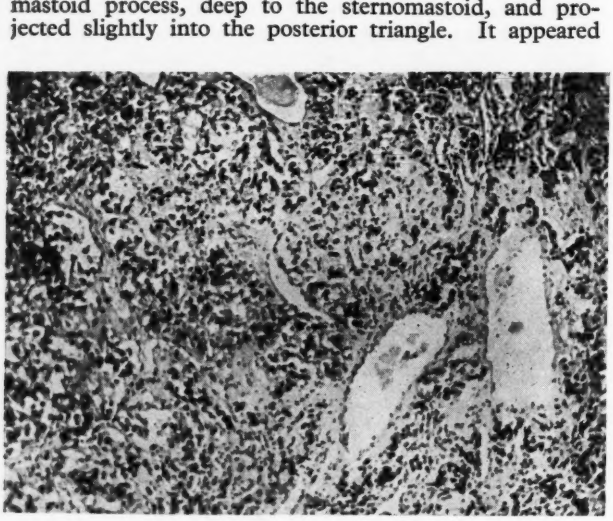

FIG. 584.—*Case* 5. Section from carotid body tumour illustrating the extreme vascularity of this cavernous type of tumour. (× 60.)

well defined and gave so distinct an impression of fluctuation that it was aspirated three times, though on each occasion without other success than to withdraw a little blood. No definite pre-operative diagnosis was made.

The lump was explored from behind the sternomastoid and found to be exceedingly vascular and rather adherent; its separation was completed everywhere except deeply and anteriorly, where it appeared adherent to the jugular vein. On direct exposure it had the spongy feel of an angioma. The attempt at removal was abandoned, a biopsy taken, and the area subsequently heavily irradiated with almost complete regression of the tumour. Post-operatively it was verified that the tumour exhibited expansile pulsation of the peculiar type commented on by Reclus and Chevassu (1903), sustained compression reducing the bulk of the tumour, which, on release, resumed its former size in a series of pulsations.

Histological examination of the biopsy specimen showed cavernous angiomatous tissue with more cellular areas of vascular parenchyma indicating a diagnosis of carotid body tumour (*Fig.* 584).

There has been no recurrence for six years.

For help in preparing this paper I wish particularly to make acknowledgement to Sir Gordon Gordon-Taylor for his interest and encouragement, and to Mr. R. Vaughan Hudson for allowing me to make use of cases which have been under his care, and for many helpful suggestions. I am most grateful also to Professor R. W. Scarff and Dr. A. C. Thackray of the Bland-Sutton Institute of Pathology, to the former for giving me access to the histological material in the Institute, and to the latter for much help in its selection and interpretation. To Professor J. D. Boyd, of the Department of Anatomy, London Hospital, my thanks are due for much advice on the morphology of the carotid bodies, whilst I am deeply indebted to Professor P. B. Ascroft, Director of the Surgical Unit, Middlesex Hospital, for his helpful surveillance, and to my colleagues on the Unit, Mr. L. P. LeQuesne and Mr. J. S. R. Golding, for their unrelenting criticism and their careful appraisal of the proofs.

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HEPATIC HYDATID DISEASE

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HYDATID disease is common in Australasia, where a Hydatid Registry is kept by the Royal Australasian College of Surgeons, in South America, and in Iceland, where Ofeigsson (1937) has demonstrated in a most striking paper the decrease in hydatid infestation in man between the years of 1867 and 1920 following intensive public health measures which restricted the indescriminate slaughter of sheep, provided for the disposal of offal, disposed of an excess of wild and stray dogs, and instructed the public in the manner of infestation from dog to man. On the other hand, Barnett (1937) showed that persuasive education by means of pamphlets and posters has not affected the incidence of the disease among the population of New Zealand, where 0·01 per cent of the population become infested each year. I have seen the disease in people from North-west India. Echinococcal infestation is common in the Near East —in Greece, Southern Italy, the Balkans, Turkey, and the Levant. In the United States of America, McGath (1940) says that almost all cases occur in persons immigrant to, but not born in, North America ; in the United Kingdom, South Wales is the commonest place for cases to be found, and Wolfe (1943) reported a number from this locality. From Algeria, Constantini and Oulié (1937) reported 230 cases. The disease also occurs in China and Russia, but not much is at present known about its distribution in those countries.

Hinshaw (1937), in his paper written from Beirut, is of the opinion that hydatid disease is commoner in the Levant than in any other part of the world. Gabrieledes, surgeon to the Government Hospital at Nicosia in Cyprus, told me that in Cyprus there are even more cases than on the mainland. From my own hospital records in Amman, Transjordan, of 600 operations in the years 1942 and 1943, 11 were for hydatid disease.

The incidence of echinococcal infestation in man is geographical, because the disease depends on the whereabouts of the intermediate hosts of the parasite, and therefore follows the distribution of sheep (or other herbivorous animals—camels, goats, pigs) and also essentially of the primary hosts—dogs or jackals.

In Transjordan, where hydatid disease has not yet been reported, the nature of the country, largely treeless and arid, encourages the Bedou to obtain his living as a herdsman of grazing sheep, goats, and camel. Dogs, tame and wild, abound in addition to jackals, and every Bedouin household owns a few watch-dogs. These dogs are not handled by the adult, being unclean animals to the devout Moslem, as Lambert Rogers (1938) has said, but they are handled a good deal by the children, and it is in infancy that infestation occurs and not in adult life as a rule. There is little control of slaughtering, and domestic dogs are indeed encouraged to feed on the offal of sheep, goats, and camel, the flesh of which is eaten by the tribesmen. As probably all dogs in that part of the world eat infected offal, the disease would be even more widespread if all became infected, but Barnett (1937) has shown experimentally that dogs have, or develop, a natural immunity to the *Tænia echinococcus*, since only one-third of dogs fed with raw infected offal became infected with the worm. Hinshaw (1937) states that of 500 dogs examined at the American University of Beirut Medical School 25 per cent were infected with *Tænia echinococcus*. Between 25 and 30 per cent of sheep and goats, 50 per cent of cattle, and all of 15 camels were affected.

From my own observations in the public abbatoir in Amman, some 12 per cent of sheep slaughtered there are infested with hydatid cysts. On conversing with the native staff, it became clear that they were unaware of the nature of the cysts in sheep's liver that they knew so well. They quite realized that this liver was not to be sent to butcher's shops as it did not appear normal and was therefore presumed to be unfit for human consumption. On the other hand, in spite of their obsequious assurances, I suspect that the infested liver was not always incinerated—to judge from the number of dogs lingering in the vicinity of the slaughter-house.

PATHOLOGY

The life cycle of the *Echinococcus granulosus* was discovered by Knabbe in 1866; this cestode usually has a cycle of development in two hosts, but this is not invariably the rule (*see below*). The adult *Tænia echinococcus* is 6 mm. in length and consists of four segments which can be found by the hundred in the upper villi of the intestine of infected dogs. About 500 ova are found in each ripe proglottis as it falls off. These are scattered by wind and water and can be ingested by the intermediate host, which may be sheep, cattle, pig, camel, or man.

Barnett (1929) points out that the infested dog's hair, paws, and muzzle are found heavily contaminated, and handling them is the method of transference from dog to man. Transference of the disease by water is much less likely as the ova sink to the bottom. The definitive host, dog, becomes infested by feeding on the offal of infested sheep, cattle, or other intermediate hosts.

When man swallows the ova, the capsules are digested and the three-spined ova make their way through the stomach or duodenum into a venous blood-vessel, and are carried up in the portal vein to reach the liver, where they may lodge in the capillaries. About 70 per cent of cysts are said to be found in the liver; some ova filter through and reach the pulmonary capillaries, where 10 per cent of cysts are located. The remaining 20 per cent of cysts occur elsewhere.

Dévé, of Rouen, and Dew, of Melbourne, have shown experimentally that ova fed to young pigs can be demonstrated in the liver and portal vein a few hours after feeding.

Though local spread of the disease in the cystic stage by secondary implantation, such as occurs following the rupture of a cyst into the abdominal cavity during operation, is well known, it is not generally realized that this means a reversion in the life cycle of the cestode: that is to say, the stage in the canine definitive host has been omitted. Dévé (1902) has shown experimentally that the parasitic element implanted aseptically into the tissues can undergo complete metamorphosis and give rise to secondary cysts.

It seems also reasonable to infer that most infestations take place during childhood, for it is at this time that hygienic habits of eating are at their lowest level and intimate contact with dogs is maximal. There may also be a factor of immunity which comes into play. This is borne out by the commonest incidence of these slow-growing parasites in the age-group between 21 and 30 years (*see Table II*). Dew (1936) himself asserts that the majority of cysts are nearly as old as the patients.

Echinococcal cysts consist of an inner parasitic element, and an outer fibrous cyst formed by fibrous tissue reaction of the host.

1. In the liver, the *Ectocyst* may be:—

a. Single. It may be spherical, or loculated in shape. The fibrous ectocyst of long standing may become very thick or even calcified; in the latter case it will be revealed on radiological examination (*see Fig.* 589).

b. Multiple.

2. The *Parasitic Endocyst* within each ectocyst may be:—

a. Univesicular, filled with clear watery fluid. This type occurs as a rule in young persons and indicates that the parasite has as yet suffered neither trauma nor infection, and that the ectocyst is intact. Univesicular caseous cysts do not occur, because caseation takes place only after the ectocyst has been damaged, and when the ectocyst has been torn or traumatized, daughter-cyst formation takes place.

b. Multivesicular, clear. The presence of daughter cysts within these parasites evidently indicates a defensive reaction of the primary parasite to trauma, in that it has multiplied and reproduced itself in order to continue the existence of the family in the face of threatened dissolution of the parent germinal layer.

c. Multivesicular, caseous. In such a case there are as a rule a few clear daughter cysts always present. It is uncommon for the entire contents of the ectocyst to consist of caseous material only. The caseous or gelatinous material present is often found to be bile-stained, indicating some degree of rupture of the ectocyst.

d. Infected cysts. These are of necessity multivesicular, since loss of continuity of the fibrous wall to some degree is implied, in order that pyogenic organisms shall have gained access to the parasite. Infection most commonly takes place by way of the biliary passages.

DIAGNOSIS

As Kneebone (1937) has pointed out, hydatid cysts in the liver are essentially latent, their growth is slow, and until some complication occurs their effect, if felt at all, is a purely mechanical one.

In my series of cases the intradermal and complement-fixation tests were never used since no filter was available to deal with the antigen before injecting it, although the latter was available. To quote Smith and McGath (1937), "The antigen for the complement-fixation test must be obtained from a cyst and must be fresh unpreserved fluid". But the same authors go on to assert that "the physician is almost wholly limited to laboratory tests in making a diagnosis". With this I cannot agree, for in most cases one was able to make a correct pre-operative diagnosis, although, to be sure, one was greatly aided by a knowledge that hydatid disease was prevalent among the patients who presented themselves for clinical examination. I was fortunate in that palpable tumours were to be felt in most of my cases, though it must be admitted that the observation of Deeds (1937) epitomizes the findings in many of these cases—"Physical examination is characterized by a paucity of clinical findings."

Frequently the patients complained of a feeling of fullness or distension in the upper abdomen made worse by exercise or by the taking of a meal. More than half were aware of the presence of a tumour and most had felt pain of no great severity, and unrelated to food, though often relieved by rest in the recumbent position. *Case* 2 of Ferris (1940) is typical of such a history.

A negative history of dysentery is possibly helpful in excluding hepatic amœbiasis.

It is of interest here to compare the symptoms complained of by Kneebone's (Australian) series of patients with the symptoms of my patients (*Table I*).

In *Case* 13 (*see below*) the cyst had ruptured intraperitoneally and there was considerable pain and tenderness in the upper abdomen but very little rigidity. It is curious that no sign of anaphylactic reaction was manifest.

Table I.—Comparison of Frequency of Various Symptoms

Kneebone (1937)		*Present Series*	
Pain and jaundice	10	Pain and jaundice	2
Anaphylactic symptoms	7	Anaphylactic symptoms	0
Pain or discomfort	7	Pain or discomfort	8
Tumour	7	Tumour	4
Dyspepsia	3	Pain and cough	1
Tumour and pain	3	Tumour and pain	10
Weak feeling	3	Weak feeling	0
	40		25

The smooth swelling or swellings in the liver are extremely suggestive in a patient who is not obviously ill if they are not tender and if they occur in the absence of positive findings in other directions; for example, the differential white blood-cell count will probably be normal, the temperature and pulse are normal, no amœbæ should be found in the stools (though fragments of hydatid membrane may sometimes be found where the cyst has ruptured into the biliary system). There may or may not be eosinophilia: even if present this has not as a rule been helpful, as eosinophilia of 3 to 10 per cent is common among the Arabs from various causes. The Kahn test and blood sedimentation rate may assist in the diagnosis of a doubtful case, and X-ray examination of the liver, though usually demonstrating nothing, may show a deformity of the diaphragm or a calcified cyst wall, as in *Case* 36. Radiological examination of the lungs should be made in every case to exclude pulmonary cysts. Hydatid thrill seems to be rather a dubious sign: I elicited it in only one instance, in *Case* 19, where there were two huge univesicular cysts.

Splenomegaly, pancreatic cyst, hydronephrosis (excluded by pyelography), and gall-bladder disease (in which cholecystography is helpful) all have to be considered in the differential diagnosis. I operated on one case of carcinoma of the liver with a subhepatic peritoneal pseudocyst (localized ascites) thinking it was an hepatic hydatid on clinical grounds.

Of cases seen 37 per cent were males and 63 per cent were females. The reason for the preponderance of females is no doubt the extreme domesticity of Arab women, and therefore the greater liability to infection, since this almost always takes place in the home. In other series the sexes are about equally affected; for example, Oulié's (1934) 135 cases were of 66 males and 69 females.

The age incidence in my series is representative (*Table II*); again comparing it to Oulié's figures,

Table II.—Age Incidence

Age	*Number*
1–10	0
11–20	4
21–30	18
31–40	19
41–50	5
51–	0

47 of his cases were in the 21–30 years age-group and 36 in the 31–40 group, due to infestation in childhood and slow development of the cyst.

It is said that cysts are common in the right lobe because of the greater width and more direct route of the right hepatic vein. Illingworth and Dick (1943) give 75 per cent right and 25 per cent left as proportionate figures. In my series 20 cysts were in the right lobe, 5 in the left, and 5 in both lobes.

Of the 28 cases under review only two had cysts radiologically demonstrable in the lungs: this is quite exceptional. Miller and Collins (1937), analysing the 268 cases recorded in the U.S.A. between 1902 and 1937, give 67 per cent only as the figure for liver involvement. H. K. Grey (1937) puts the figure as 75 per cent from his investigations at the Mayo Clinic.

Cysts in persons under the age of 25 tend on the whole to be univesicular; in persons over 30 years they tend to be multivesicular. Whether there are multiple cysts or whether there is but one cyst appears to bear no relation to age.

TREATMENT

The cases of liver hydatid here presented are 16 personal cases and 22 other cases, mostly operated upon at the Italian Hospital, Amman, Transjordan, and previously unpublished (*see Table* IV). It is perhaps of interest that when the hospital first functioned under the auspices of the newly-appointed Italian surgeon, echinococcal disease was not suspected, for the first case was aspirated only under local anæsthesia, and the second one died after operation of anaphylactic shock (following peritoneal soiling with hydatid fluid). Thereafter cases were dealt with by laparotomy, excision of the parasite, and closure or drainage of the fibrocyst as the circumstances indicated. There was one further death.

The sixteen personal cases were dealt with as described below.

Anæsthesia.—Spinal anæsthesia was used as routine, on account of the unreliable general anæsthetics administered by Italian nuns; 12.0 c.c. of 1–1500 light nupercaine was the dose used. No untoward effects were noted, though, as Dévé (1911) has stated, there is a risk of anaphylactic shock during the operation unless general anæsthesia is employed.

Approach.—As most palpable cysts presented in the right hypochondrium, or epigastrium, a right paramedian incision was used as routine, splitting the rectus abdominis vertically, giving better exposure than displacing it laterally. Even for a cyst in the left lobe it is probably wiser to use a right-sided paramedian, for as a rule the left hepatic lobe is easily accessible through such an incision; but the main advantage is that any additional and clinically impalpable cysts in the right lobe can be dealt with at the same operation. This would not be feasible through a left-sided incision.

A right costal incision with rib resection was used as required, but only for 4 cases (*Cases* 16, 26, 35, and 36). For example:—

Case 35.—A 30-year-old English female cotton worker gave a history of attacks of pain in the right hypochondrium of 12 years' duration. She was a stout woman with a tender mass in the right hypochondrium. The Casoni reaction was positive.

At operation on Jan. 15, 1948, a large hydatid cyst was excised from the left margin of the left hepatic lobe complete with ectocyst.

At a second operation on Feb. 12, 1949, a large cyst in the right lobe of the liver was marsupialized by an approach through the bed of the resected 12th rib. Daughter cysts were frequently discharged during convalescence.

The advantages of an abdominal over a thoracic approach are decisive :—

1. In every case the whole liver must be examined as cysts are so frequently multiple ; this cannot be done through a thoracic incision. The pelvis should be examined for implanted cysts.

2. The risk of contamination of the pleura and of pulmonary complications is high with procedures on the liver following rib resection.

Barnett (1938), quoting the statistics of the Hydatid Registry of the Royal Australasian College of Surgeons, shows that the mortality of operations by the transthoracic route is double that of the operation by the abdominal route. Of course, an approach by rib resection has to be used when the cyst is on the posterior surface of the liver, as in *Cases* 35 and 36, or where there are pleural or pulmonary complications.

Clear free fluid was fairly frequently found on opening the abdomen. As a rule, this was ascitic fluid, secreted by the peritoneum, and doubtless provoked by the proximity of a cyst to the serous surface of the liver, but in one instance it was actual hydatid fluid from the mechanical rupture of a cyst (*Case* 13). A history of acute pain usually precedes such an operation finding. The nature of any clear fluid found on opening the peritoneum, then, is of some moment, for it affects profoundly the long-term prognosis ; in any case of doubt it should be examined microscopically for scolices.

The whole liver should invariably be palpated carefully, for, in addition to the clinically obvious cyst for which the operation has been undertaken, there may be present other cysts in other parts of the liver which have not previously been detected. For example, in *Case* 23 an additional very small cyst was discovered on the lateral aspect of the right hepatic lobe after the cyst for which the operation had been undertaken had been dealt with.

Preliminary pre-operative diagnostic puncture was never attempted, and is much to be deprecated both on the grounds of the immediate danger from anaphylaxis, and of remote risk from general peritoneal contamination with scolices and from subsequent cyst formation.

On the other hand, after the peritoneum had been opened and the cyst isolated from the rest of the peritoneal cavity with gauze, puncture with a wide-bore needle was always made, as it indicated the type of cyst being dealt with, relieved tension in the cyst, and enabled the preliminary injection of a quantity of formalin solution to be made, in the hope of killing or inactivating parasitic elements which are liable to escape into the peritoneum on incising the cyst wall, though every precaution is taken to prevent this occurrence. In this connexion it is worthy of mention that extra gauze packing should be at hand, for the ectocyst frequently collapses rapidly once it is incised ; thus it may suddenly recede from the gauze packing previously placed in contact with its outer surface, and should any fluid escape from the incised cyst it will run down into the peritoneum and may give rise to secondary echinococcosis at a later date from implantation of scolices unless the packs are reinforced. It is advisable to moisten the more superficial packs with formalin solution. As is well known, it is safer to use gauze dyed black, but this is feasible only in hospitals where hydatid disease is frequently encountered.

In most cases, the tough white fibrous avascular ectocyst had presented against the ventral parietes and was readily incised. In other instances, owing to the fibrous wall presenting on some aspect of the liver which was either inaccessible or unsuitable for dependent drainage, liver tissue was incised with the diathermy in order to reach the cyst. As has been mentioned, a transthoracic approach may have to be made, but only after laparotomy has demonstrated that an abdominal access is inadequate and that other cysts do not require treatment.

Treatment of the Parasite.—As has already been mentioned, having aspirated some hydatid fluid, formalin solution was invariably injected into the parasite before incision of the fibrous wall, and the utmost precautions were taken to prevent spilling of the cyst contents into the peritoneal cavity. The classical method of enucleation was employed by Knowsley Thornton (1883), who showed that the endocyst could safely be removed without fear of hæmorrhage.

But Thomas (1894) gives an excellent description of the operation of ' marsupialization ', which he says was first performed by Lindemann in 1871.

Single endocysts could invariably be coaxed out in one piece, as they are never adherent, and can be gently withdrawn with sponge forceps or lung forceps through the opening in the ectocyst.

Daughter cysts when present at all usually numbered hundreds, and were scooped out most easily with a domestic tablespoon. In the larger cysts a mechanical sucker was employed to evacuate the fluid, which in *Case* 20 amounted to over six pints.

All examples of infected or caseous cysts contained many daughter cysts in various stages of degeneration, and in such cases some parts of the parasite were invariably found to be adherent to parts of the fibrous capsule, and were curetted away as far as was feasible, bearing in mind the dangers of opening one of the larger vascular or biliary channels. Finally, the cavity was swabbed out with strong formalin solution.

The fibrous wall of a univesicular cyst is as a rule thinner and more pliable than that of the multivesicular variety, especially if the latter be of the kind in which many of the cysts are caseous, or indeed if some, or all, of the mother cyst is replaced by a glutinous or even a caseopurulent mass.

So that whereas the parasite is easily extracted *in toto* from a univesicular cyst, when a multiple cyst is being dealt with, particularly if part of it is necrotic and scarcely recognizable as of echinococcal origin, and especially in those cases in which the fibrous wall is not spherical in shape, but has diverticula and sacculations budding off into the lobes of the liver, it is necessary to scoop out the parasite piecemeal. And then even after careful lavage with formalin and meticulous search for bits of parasite with the

aid of a head-lamp, the ectocyst may have to be curetted to scrape away adherent parasitic elements. Such a case may continue to discharge flakes of echinococcal material or even small daughter cysts (which either were left in some recess, or have developed from scolices remaining) for many weeks, subsequent to operation.

For example, in *Case* 21 a multivesicular cyst in the right lobe of the liver was dealt with by excision of the parasite and drainage of the ectocyst, yet a complete daughter cyst was shed from the sinus on the fifteenth post-operative day. The patient returned to full duty as a soldier. Similarly in *Case* 22 several daughter cysts were discharged from the sinus by which a large multivesicular cyst in the right hepatic lobe had been drained after excision of the parasite. The woman subsequently made a good recovery.

TREATMENT OF THE FIBROUS WALL

The three methods of dealing with the ectocyst are :—

1. The ectocyst may be excised from the liver unopened.

2. Having opened the ectocyst and removed its parasitic contents, the cavity remaining may be closed.

3. The cavity may be drained.

1. Excision.—It is quite remarkable that in spite of the voluminous literature on this subject, there still appears to be a divergence of view on this point of the treatment of the ectocyst, which is the core of the operative problem. Although Kneebone (1937) says, " It is difficult to find any aspects of hydatid disease that have not already been dealt with exhaustively, and in many cases, it would seem, finally ", in 1936 Melinkoff, of Kharkov, in a paper presented to the Rostov Congress, stated that drainage of an hydatid cyst merely transformed a parasitic cyst into a non-parasitic pseudocyst, and that the operation of choice was therefore the excision of the unopened cyst. On the other hand, Costantini and Oulié (1937) argue extensively that on no account should excision of the entire cyst be performed. This is the general view of the Australasian, South American, French, and German surgeons, unless in such obvious exceptions as pedunculated cysts, as in *Case* 35. The good prognosis offered by the more conservative methods of closure or drainage far outweighs any theoretical advantage of complete excision with its heavy operative mortality from liver hæmorrhage.

With regard to the remaining two methods of treatment, finality has not yet been reached.

2. Closure.—E. R. Cunliffe (1935) states that American surgeons rarely, if ever, employ primary suture of the ectocyst—or even removal of the parasite and drainage. Cunliffe's case was operated upon in three stages, necessitating a period of seventy-nine days in hospital, using marsupialization and packing of the cyst with iodoform gauze. D. O. Ferris's (1940) two cases were dealt with at the Mayo Clinic by two-stage operations : he left part of the abdominal incision unclosed, securing adhesions of the peritoneum and parietes by the use of iodoform gauze, and, having opened and evacuated the cysts after two weeks, he packed them with iodoform gauze, necessitating thirty-six and fifty-nine days in hospital in the respective cases.

Grey (1937), of the Mayo Clinic, discusses the three-stage operation. His own case was done in one stage with excellent results, but he advocates drainage in all cases on the grounds of safety.

Evidently the multi-stage operation is also practised in Germany. W. Baltin (1938) describes a case at which the ectocyst was sewn to the parietes at the first operation ; it was opened after ten days, and after numerous lavages with formalin, and periodic removals of daughter cysts, he announces nearly five weeks after operation that " The whole cyst membrane became necrotic and was removed from the cavity of the ectocyst ". The wound did not heal until eight weeks after operation.

Dew (1929) subdivides closure into three subcategories in his paper on operative treatment, according to whether the closed cyst is attached to the ventral parietes or not, and in what manner.

It seems logical that every case with a single uninfected univesicular cyst of moderate size should be filled with saline and closed completely after treatment of the wall with formalin, the parasite having been removed. But owing to the definite risk of infection in the closed cyst (*Cases* 32, 34) it should be attached to the ventral parietes in the vicinity of the incision whenever possible.

M. G. Oulié (1934) mentions a case in which death ensued from peritonitis following a second operation upon an ectocyst which had been closed at operation without parietal fixation, the closed cyst having become infected with pyogenic organisms.

Dew himself, in discussing the post-operative complications, says that pyrexia which reaches any height in the case of cysts which have been closed usually means infection in the cyst, and requires the reopening of the wound, and the institution of drainage. In this connexion it is plain that if the cyst be closed without parietal fixation, then the risk of contaminating the peritoneum, should drainage have to be instituted later on account of secondary pyogenic infection, is considerable, for the peritoneal cavity has to be opened in order to find the cyst, whereas with parietal fixation the cyst can be approached without opening the peritoneum. Costantini and Oulié (1937) published some very convincing statistics (*Table III*) of 70 operations on univesicular uninfected cysts.

Table III.—DETAILS OF OULIÉ'S CASES

63 closed	37	healed by first intention
	7	infection in the wound
	16	necessitated re-opening
	3	deaths
7 marsupialized	7	cured

It is most striking that 26 of his 63 cases treated by primary closure developed complications, and 3 actually died. These figures are unquestionably a deterrent to the indiscriminate closure of the adventitia, and in my experience the presence of a small drainage tube does not necessarily lead to prolongation of the time of convalescence—*Cases* 17 and 18 both left hospital with healed sinuses on the twelfth post-operative day. In each of these patients a single clear univesicular cyst was present, and

after excision of the parasite *in toto*, a narrow-bore rubber drain was left in the ectocyst cavity for forty-eight hours. Follow-up revealed no recurrence eighteen months later.

On the other hand, while most uninfected univesicular cysts which are treated by primary closure made an uninterrupted recovery, there may be moments of anxiety, as in *Cases* 32 and 34 (*see below*).

J. C. Lehmann (1928) states that one of the dangers of primary closure is that daughter cysts left behind may continue to grow. The same author states further that 20 per cent of 137 cases with closure taken from the literature which were primarily aseptic became infected. Of these cases 109 were cases from the Argentine, published by Negas and Cranwell and quoted by Lehmann, with a mortality of 6·7 per cent. They compare this with 245 cases with drainage published by the same authors with a mortality of 4 per cent.

In the case of a cyst which is closed at the primary operation after removal of the parasite, the cavity must persist as a pseudocyst or a sterile abscess for many weeks or months before it is completely obliterated.

If secondary infection occurs in a cyst which it has been deemed wiser to drain, then drainage may continue for many months until the cavity has been healed by granulation. On the other hand, if secondary infection can be prevented by scrupulous post-operative care in respect of dressings, or if in these cases which were infected *per primam* infection can rapidly be overcome and further infection from without prevented, then the drainage sinus may become closed with safety before the actual cavity of the adventitia has become obliterated. That this can take place is demonstrated by the following case-history :—

Case 25.—On September 13, 1944, I removed the parasite from a multivesicular caseous hydatid cyst in the right lobe of the liver of a 22-year-old Indian soldier.

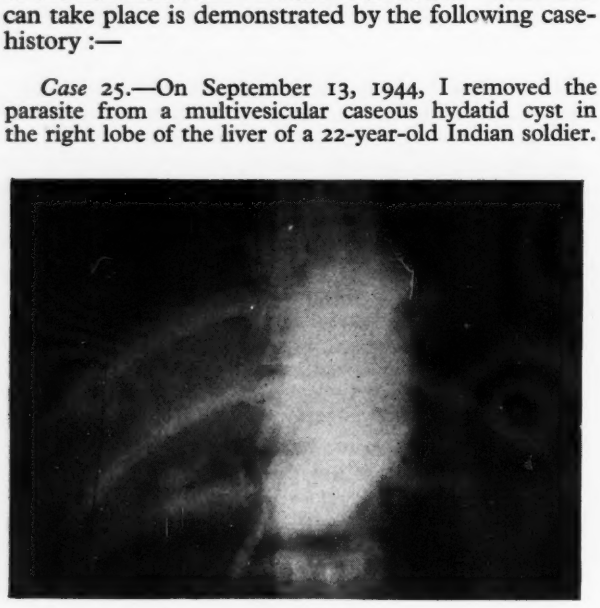

FIG. 585.—*Case* 25. Cavity in liver after removal of cyst, outlined by sodium iodide solution.

After washing out the cavity with formalin a tube drain was left in it. On Oct. 3 the sinus was almost healed, so I decided to see whether the cavity of the ectocyst had collapsed. On introducing 250 ml. of 15 per cent sodium iodide into the ectocyst cavity a radiological picture was obtained (*Fig.* 585) demonstrating a considerable cavity. Only five days after this demonstration the sinus was healed and dry and remained so. It is inconceivable that complete collapse and fibrosis of such a cavity had taken place in only five days. We must therefore conclude that the sinus closed while a considerable cavity remained.

So that although the ectocyst has had a drainage tube in the beginning, the track rapidly closes when this is removed if infection has been avoided, and we are left with a closed ectocyst, filled with serum, which must continue to exist as a sterile pseudocyst for some months.

Further evidence of the fate of the cavity of the ectocyst is provided by Lehmann and Kahlsdorff (1938), who published an account of a case in which removal of two hydatid cysts from the liver having been undertaken in the usual way, the patient died of actinomycosis of the liver nineteen months later. At the autopsy, quite apart from the actinomycotic lesions, the two cavities from which the echinococcal cysts had been removed were still present, one 6 × 2 × 1·5 cm., and the other 4·5 × 2 × 1·5 cm. Microscopically these cavities were fibrous walled and had a thin granular lining of a non-epithelial character. One of the walls was partly calcified.

J. Ramsay (1913) instances the case of a small thick-walled residual adventitious sac being found at post-mortem in a man who died from another cause.

The implication of this persistence of the ectocyst cavity is that years later a secondary infection may arise in the pseudocyst, necessitating further surgical intervention.

3. Drainage.—Drainage should always be instituted where there are very many daughter cysts, in particular if there be infection present, or if the parasite be in places necrosed, glutinous, gelatinous, or caseated in appearance, or if the cyst contents are bile-stained. It is probably wiser to drain cysts of exceptionally large capacity, and cases in which one cyst is opened through the wall of another, even if the parasites are univesicular (as in *Case* 19).

It is in these cysts which require prolonged drainage and which are either infected *per primam* or become secondarily infected, that the period of convalescence is so long. Lehmann (1928) states that at the Rostock Clinic the average duration of treatment was forty-three days, and they gave their opinion that the time of cure in good cases is from three to six months, the fistulæ draining for months or even years after operation!

The caseous cyst is one which has suffered a rupture of its ectocyst. It should therefore be drained on account of its greater liability to infection, and because the toxæmia from a cyst, the wall of which is not intact, is likely to be more severe, since infective spread into the blood-stream or biliary system is then possible. Ruptures large or minute in the fibrous wall (which we know must exist in all multivesicular cysts) will permit spread of infection, if it occurs, unless the cavity is drained.

Accepting that these cysts have to be drained, in order to diminish the usual lengthy stay in hospital of such cases, the following measures were adopted:

1. Care was taken to ensure that as far as possible the opening in the ectocyst would be in such a place

that gravity-assisted drainage was permitted after operation.

2. The patient was nursed for the first post-operative week lying on the abdomen, since drainage was made through the upper part of the paramedian incision whenever possible. On the other hand, A. Wybert (1939), of Buenos Aires, who usually employs the method of marsupialization and drainage, says that he puts his patients in the Trendelenburg position after operation, to aid the collapse of the cyst and to help aeration of the lungs.

3. Mattress sutures were inserted within the ectocyst to cause its collapse. Later observations showed that this was futile, as the cavity persists. This manœuvre has therefore been abandoned.

4. All dressings were changed in the operating theatre with the most scrupulous aseptic technique.

5. Chemotherapy was employed when indicated.

As a rule, it is easier and quicker to drain the upper part of the paramedian incision than through a stab drain, though from the very situation of the cyst or cysts, separate stab drains may have to be employed. In this connexion several desiderata have to be fulfilled :—

a. Drainage should not tend to give rise to subsequent incisional hernia.

b. Pyogenic infection of the rectus sheath, particularly in cases of primarily infected or suppurating cyst, is to be avoided.

c. Secondary echinococcosis of the rectus muscle prevented. *À propos* of secondary implantation cysts in the peritoneum and abdominal wall, Harold Dew (1929) said, " The frequency of this complication has not been sufficiently recognized ". As I have shown above, daughter cysts or scolices may be shed, from a caseous-type cyst in particular, for some time after operation, even if all parasitic tissue has been apparently removed, and in spite of formalin treatment of the inner surface of the ectocyst at operation.

d. Fixation of the cyst to a known, identifiable part on the parietal peritoneum is desirable, so that in the event of any subsequent inflammatory trouble

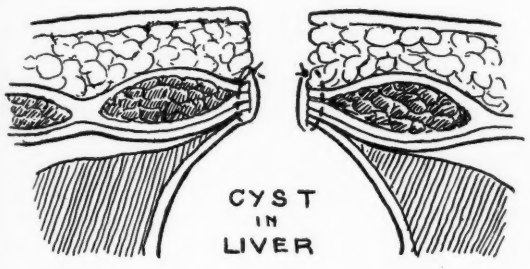

FIG. 586.—Transverse section in upper part of incision, showing ostium made into cyst.

the cyst can be located without having to open the general peritoneal cavity.

With this in mind, the following method of drainage was used : The two margins of the vertical openings made in the ectocyst were sutured separately with interrupted catgut sutures to peritoneum, posterior rectus sheath, and anterior rectus sheath on each side as one layer, so that the ostium of the cyst cavity communicated with the outside, but was shut off from the rectus muscle and sheath (*Fig.* 586). In the lower part of the incision closure was made

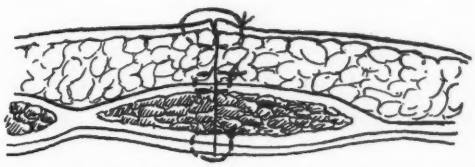

FIG. 587.—Transverse section in lower part of incision, showing normal closure in layers.

in the usual way—that is to say, peritoneum and posterior rectus sheath as one layer and the anterior rectus sheath as one layer (*Fig.* 587).

In this way the possibility of subsequent hernia is minimized, rectus-sheath infection and secondary echinococcosis of the rectus sheath are prevented, drainage is ensured, and fixation of the ectocyst to the parietes is established at a definite spot. The ostium can be made as small or as large as desired.

One's personal impression was that a much sounder wound was obtained, and certainly no troublesome low-grade suppuration occurred in the rectus sheath.

I formed the opinion then that :—

1. The correct treatment of univesicular cysts was closure without drainage, but leaving the fibrous wall fixed to the parietes, if convenient.

2. Multivesicular or caseous cysts should have a narrow-bore drainage tube left in for 48 hours, since it minimizes the risk of infection and does not add to the period of convalescence.

3. Infected cysts should be drained with a narrow-bore drainage tube, and local chemotherapy should be employed.

CHEMOTHERAPHY

Chemotherapy may be employed in hydatid disease, locally or systemically, in cases which are infected or are likely to become infected.

If infection appears to be confined to the cyst cavity then local chemotherapy may be used, since it is unlikely that drugs administered parenterally or by the mouth will penetrate the impermeable avascular ectocyst to reach the cyst cavity in any appreciable concentration. However, since one must still treat the ectocyst with strong formalin at operation, there is little point in commencing local chemotherapy until some forty-eight hours have elapsed, as penicillin, streptomycin, or the sulphonamides are likely to be destroyed if administered before that time.

Dew (1928, a) states that streptococci or *B. coli* are the usual contaminants of drained cysts, and he also says that in 20 per cent of cases the infecting organism is an anaerobic bacillus.

In *Case* 25 (*see above*) the result of local chemotherapy was hardly spectacular, but the *B. coli* could be cultured from the cyst *ab initio*, so it is possible that a more serious infection was averted. In the case of infected cysts local chemotherapy may be employed with advantage, say 50,000 units of penicillin and 1·5 g. of sulphadiazine in 20 c.c. of sterile saline, twice daily.

On the other hand, in some cases, post-operative pyrexia may be caused by a pericystic hepatitis. That is to say, there is local spread of infection through a defect in the ectocyst which involves the liver parenchyma in the vicinity of the cyst. This type of infection is logically treated by systemic chemotherapy. *Cases* 32 and 34 are examples of this :—

Case 32.—A 48-year-old Arab woman had a univesicular cyst excised from the right hepatic lobe, the ectocyst being closed without drainage. On the twelfth post-operative day she complained of pain in the right hypochondrium, when an enlarged tender liver was found and the temperature rose to 102° F. After a course of 28 g. of sulphapyridine by mouth the pyrexia subsided and the pain disappeared.

Case 34.—Three large univesicular cysts were removed from the liver of a male Arab, 20 years of age. After operation he had an irregular temperature associated with an enlarged tender liver for eighteen days. The pyrexia subsided after a course of 30 g. of oral sulphathiazole.

COMPLICATIONS

There are two common complications of hepatic echinococcosis—infection and rupture.

1. Infection.—This may be acute or chronic; it demands surgical intervention and precludes primary closure of the fibrous cyst when the parasite has been removed. Infection probably implies some degree of rupture of the fibrous cyst. For example :—

Case 30.—A male Arab, aged 35, complained of gradually increasing abdominal swelling of four years' duration. More recently he had had indigestion, malaise, loss of weight, dyspnœa, and fever.

Examination showed him to be jaundiced and febrile, with a temperature of 100·5° F. There was a huge, tense, tender abdominal tumour 10 cm. in diameter, which appeared to be continuous with the liver. Sulphathiazole 1·0 g. four-hourly was given for four days, resulting in marked general and local improvement.

At operation, under spinal anæsthesia and through a right paramedian incision, several large hydatid cysts were found to be causing gross liver enlargement. These cysts were marsupialized after removing the parasites, but one was grossly infected, and, after stripping it of adherent omentum and colon, pus began to well up from it. Four litres of pus were evacuated with the mechanical sucker, as well as many daughter cysts. The abdomen was closed with a large tube in the hepatic abscess and another in the subhepatic region.

No organisms were grown from the pus. The temperature settled after ten days, but nearly two litres of turbid bile-stained fluid drained daily from the abscess for two weeks. A sinus persisted for seven weeks and the patient was discharged well after eight weeks.

See also Cases 26 and 28.

2. Rupture.—Of rupture Dew (1936) states that practically all symptoms depend on some degree of rupture : from this it follows that almost all cases seen have suffered rupture to some extent. This is probably so, but in describing 'rupture' as a complication one means as a rule gross rupture with parasitic elements making their way through the traumatized endocyst and ectocyst, not a minute splitting of the fibrous cyst permitting the contact of parasite and liver cells through the medium of plasma.

a. Intrabiliary rupture is common, and is responsible for biliary colic symptoms in this disease; it may lead to obstructive jaundice. A. J. Mason (1937) instances a case in which the entire cyst, the size of a tangerine, spontaneously evacuated itself from the liver by way of the common bile-duct in a girl only 12 years old.

We have already assumed that a multivesicular cyst has minute ruptures in its fibrous wall; it would seem that the very act of operation on such cysts tends to release one or more daughter cysts into the biliary passages. I noted the following post-operative disturbance which I believe to be of this nature :—

Case 15.—On May 28, 1942, I removed the hydatid parasites from a large multivesicular cyst in the right lobe of the liver of a 45-year-old Arab woman. The ectocyst was marsupialized. After operation there was a copious and deeply bile-stained discharge from the sinus, and the stools were clay-coloured from June 2 to June 10. On June 14 the stools again became normally pigmented *after the discharge from the incision had ceased to be bile-stained.*

The implication is plainly that a daughter cyst had escaped through a small unnoticed rupture in the ragged wall of the ectocyst into the biliary system, and, having lodged for a few days in the common bile-duct, ultimately was passed into the duodenum, perhaps through the cyst itself rupturing.

Case 17.—A 30-year-old Arab was admitted feverish and cachetic, with jaundice and clay-coloured stools, and a right-sided pleural effusion from which I aspirated 300 c.c. of clear fluid on Sept. 13, 1942. Jaundice diminished and the stools became coloured. At laparotomy on Sept. 17 the liver was found riddled with abscesses containing thick yellow pus and also many small hydatid cysts. The gall-bladder and bile-ducts appeared normal. The patient's condition gradually deteriorated and he died on Oct. 6.

In this case laparotomy was only undertaken with some misgivings. This liver was riddled with abscesses; whether these were multiple suppurating hydatid cysts (for two clear cysts were present) or whether the pathological process was a portal suppurative thrombophlebitis will never be known, for a post-mortem examination was not permitted. It seems possible, and indeed almost probable, that this was a case of alveolar echinococcosis, as described by Dew (1928, b); indeed Barnett and Meade (1941) state that in sporadic cases the ordinary echinococcal cysts are frequently found in addition to echinococcosis alveolaris, and that persistent jaundice is common in these cases. *See also Case* 36 quoted below.

b. Intraperitoneal rupture is fairly common, and may be associated with anaphylactic manifestations, and is often followed by secondary echinococcosis of the peritoneum; in my case (*Case* 13, *see below*), no anaphylactic symptoms or signs were manifest for two years, and there was no evidence of secondary implantation cysts in the peritoneum. I have had news that in November, 1945 (nearly four years after operation), she reported to hospital with pelvic hydatid cysts.

Case 13.—A 30-year-old Arab woman was admitted complaining of severe upper abdominal pain of three

days' duration. On examination there was muscle guarding in the upper abdomen and a smooth tender tumour was present in the right hypochondrium. No signs of anaphylaxis were present. At operation, under ether anæsthesia, on Feb. 10, 1942, clear, free fluid was found on opening the abdomen, and a ruptured hydatid cyst was present in the right hepatic lobe. The parasite was excised and the cyst closed. She made a good recovery, and when I saw her two and a half years afterwards was fit and well, and had borne a child, but four years after operation pelvic hydatid cysts became manifest.

c. Intrathoracic rupture is not uncommon. Treatment is symptomatic, for the cyst may rupture into the pleura or directly into a bronchus if sufficiently dense adhesions have been formed between the diaphragm and the lung. For example :—

Case 29.—A 35-year-old Italian soldier first felt pain in his right side in March, 1945.

In June, 1945, " a large clear cyst " in the right lobe of the liver was drained through a right paramedian

FIG. 588.—*Case* 29, showing lipiodol in (1) abdominal sinus, (2) cavity in liver, (3) pulmonary alveoli.

incision. The hydatid complement-fixation test was positive.

On November 23, 1945, he had a clear right pleural effusion and a thick-walled abscess cavity in the liver. Both were aspirated. Lipiodol injection into the abdominal sinus remaining from the first operation outlined a cavity in the liver which communicated with the bronchial tree (*Fig.* 588).

The patient was evacuated to Italy and contact with him was lost.

d. Rare ruptures—into blood-vessels or externally.

Calcification in the wall of the ectocyst (*Fig.* 589) affects prognosis considerably as it prevents collapse of the fibrous wall, but may be dissolved over a period of months by lavage with dilute acids. It is not prudent to operate upon these cases if it can be avoided. Frequently the parasite itself is dead in these cases, for example :—

Case 36.—A 47-year-old English quarry worker in March, 1947, had an attack of painless jaundice lasting one week. In May he had an attack of severe pain

FIG. 589.—Calcified cyst in the liver of *Case* 36.

in the right hypochondrium, lasting several days, accompanied by vomiting and jaundice, and in July he had a similar attack of pain in the right hypochondrium.

Cholecystogram showed no dye concentration in the gall-bladder region, but an irregular opacity, about 2 in. in diameter, overlying the 10th right rib (*Fig.* 589). There were no positive physical signs on examination of the abdomen. Casoni antigen not available.

During the War of 1914-18, while he was in Iraq, he had an Arab dog with which for a period of about a year he used to play.

Operation on Feb. 19, 1948, under general anæsthesia : The abdomen was opened through a right paramedian incision and it was confirmed that on the outer surface of the liver there was what felt to be a partially calcified cyst ; the superficial part of this was soft and fluctuant. The gall-bladder appeared healthy and emptied freely. The common bile-duct was somewhat distended and was therefore explored and the probe was found to pass freely into the duodenum and no cysts were located after washing out the biliary system with saline. A hydatid cyst, 5 cm. in diameter, was located attached to the splenic flexure of the colon. This cyst was excised complete and the abdomen closed.

Operation, March 4, 1948, under general anæsthesia : An incision, 5 in. in length, was made over the 10th right rib, extending forwards. The 10th rib was resected for 3½ in. and the pleural cavity was opened, the lung packed off, the diaphragm incised, and the hydatid cyst in the liver aspirated. Only thick yellow pus was found, which was sterile on culture. The cyst was therefore presumed dead. The diaphragm was repaired, the chest incision closed, and the pleura aspirated of air. Convalescence was uninterrupted.

PROGNOSIS

Prognosis in hydatid disease depends primarily on the presence or absence of complication. In my personal series of 16 cases there was 1 death—a

mortality of 6·2 per cent. Grey Turner (1943) quotes McLourin, of Sydney, as having 7 deaths in 70 cases, each fatal case having one or other complication. Oulié had an 11 per cent mortality in his series published in 1934.

Uncomplicated Cysts.—

1. Single univesicular cysts usually require less than two weeks in hospital.

2. Multiple univesicular cysts may require longer, particularly if they are large in volume,

Table IV.—Details of 36 Cases

Case	Age	Sex	Type of Cyst	Treatment	No. of Days in Hospital	Result	Follow-up
1	22	F.	Single univesicular clear	Aspiration	1	R.	
2	35	F.	Hepatic	Excision of parasite	5	D.	
3	30	F.	Hepatic	Excision of parasite	10	R.	
4	20	M.	Hepatic right lobe	Excision of parasite. Rib resection and drainage	45	R.	
5	42	F.	Single hepatic	Excision of parasite	40	R.	
6	28	F.	Single univesicular clear. Hepatic right lobe	Excision of parasite	15	R.	
7	25	M.	Single multivesicular suppurating hepatic	Excision of parasite	21	R.	
8	34	F.	Hepatic right lobe	Excision of parasite. Rib resection (8) and drainage	10	R.	
9	30	F.	Single univesicular clear. Hepatic right lobe	Excision of parasite. Closure	49	R.	
10	30	F.	Multiple multivesicular caseous. Hepatic right and left lobes	Excision of parasites. drainage	65	R.	
11	50	M.	Single univesicular clear. Abdominal wall	Excision. Closure	21	R.	
12	30	F.	Single two univesicular clear. Hepatic right lobe	Removal of parasite. Closure	17	R.	
13	30	F.	Single univesicular clear (had ruptured into peritoneal cavity). Hepatic left lobe	Removal of parasite. Closure	14	R.	Recurrence—pelvic cysts present 4 years after operation Pelvic cysts detected 3 years 9 months after
14	38	F.	Single multivesicular caseous. Hepatic right lobe	Removal of parasite. Drainage	39	R.	
15	45	F.	Single multivesicular caseous. Hepatic right lobe	Removal of parasite. Drainage	39	R.	Well, with no recurrence 2 years after operation
16	27	M.	Single multivesicular infected ++. Hepatic right lobe	Drainage by rib resection	28	R.	Sinus discharged till 35 days. Well, with no recurrence 3½ years after after operation
17	30	M.	Multiple multivesicular infected. Hepatic right and left lobes	Laparotomy only	18	D.	
18	25	F.	Single univesicular clear. Hepatic right lobe	Removal of parasite. Drainage	12	R.	
19	40	F.	Single univesicular clear. Hepatic left lobe	Removal of parasite. Drainage	12	R.	Well, with no recurrence 1 year after operation
20	24	F.	Two univesicular clear cysts. Hepatic right lobe	Removal of parasites. Drainage	32	R.	Well, with no recurrence 1 year after operation
21	22	M.	Single multivesicular caseous. Hepatic right lobe	Removal of parasite. Drainage	26	R.	
22	25	F.	Single multivesicular caseous. Hepatic right lobe	Removal of parasites. Drainage	32	R.	
23	40	F.	Single multivesicular caseous. Hepatic left lobe	Removal of parasite. Drainage	30	R.	Well, with no recurrence 10 months after operation
24	35	F.	Multiple: 5 univesicular clear; 2 multivesicular caseous. Hepatic right and left lobes	Removal of parasites. Some cysts closed, some drained	—	R.	
25	22	M.	Single multivesicular caseous. Hepatic left lobe	Removal of parasite. Drainage	35	R.	
26	40	M.	Single multivesicular suppurating. Hepatic right lobe	Drainage. Rib resection for empyema	150	R.	
27	21	M.	Single left pulmonary	Removal of parasite. Closure	150	R.	
28	18	M.	Single multivesicular suppurating. Hepatic right lobe	Drainage	120	R.	
29	35	M.	Single multivesicular. Developed bronchial fistula. Hepatic right lobe	Drainage	270+	R.	
30	35	M.	Multiple multivesicular suppurating. Hepatic right and left lobes	Evacuation and drainage	59	R.	
31	28	F.	3 univesicular clear. Hepatic tuberculosis. Also ileocæcal tuberculosis	Removal of parasite. Closure	20	R.	
32	48	F.	Single univesicular clear. Hepatic right lobe	Removal of parasite. Closure	16	R.	
33	22	F.	Single univesicular clear. Hepatic left lobe	Removal of parasite. Closure	15	R.	
34	20	M.	3 univesicular clear. Hepatic right lobe	Removal of parasites. Closure	25	R.	
35	30	F.	2 multivesicular	One excised, one marsupialized	55	R.	
36	47	M.	2, one calcified, one multivesicular	One excised, one aspirated (dead)	26	R.	

or if one cyst has to be opened through the wall of another.

3. Multivesicular cysts, particularly if their contents are caseous or necrotic, require drainage, and are inclined to have a protracted convalescence; drainage may go on for months, and secondary infection is very difficult to avoid. These are the people who are likely to benefit by local chemotherapy. The manœuvre for dealing with the rectus sheath described above was designed to avoid infection of the rectus sheath and to obviate post-operative hernia.

In uncomplicated cysts there should be no operative mortality.

Complicated Cysts.—

1. *Rupture.—*

a. Intrabiliary rupture, if recognized, is treated by removal of the main parasite with or without exploration of the bile-ducts. On the whole, the prognosis is good.

b. Intraperitoneal rupture: There may be rapid death from shock, from anaphylaxis, or from operative interference, and in any case there is a very strong probability that generalized echinococcosis of the peritoneum will supervene after a period of years, as in my own case. This complication carries a poor prognosis.

c. Intrapleural rupture necessitates immediate surgical intervention and greatly increases mortality.

2. *Infection.*—Provided that early drainage is instituted the prognosis is quite good, and risk to life from spread of infection into the liver or peritoneum is small. Chemotherapy has greatly diminished the mortality of such cases. In non-fatal cases a sinus is likely to persist for some time until the cavity has healed by granulation.

Calcification in the fibrous wall will plainly interfere with collapse of the cyst cavity, and may cause drainage to continue for years after operation. Devine (1940) does not advocate operative interference in such cases, on the grounds that in such an old cyst the parasite is likely to be dead. Barnett (1938) recommends washing out the cavity with dilute acids when such cases have to be submitted to operation, in order to dissolve the calcium.

SUMMARY

A series of cases of hydatid disease of the liver is here presented, of which 16 are my personal cases, the others mostly being operated upon at the same hospital.

It is suggested that this disease is found in fairly clearly-defined stages, and that each stage in which the parasite is found requires a definite method of treatment, and carries a definite prognosis which can be accurately forecast.

The effect of chemotherapy is also discussed.

It is a pleasure to thank Mr. R. L. Holt for permission to quote *Cases* 35 and 36; Captain R. South and Captain M. G. Wilson to quote *Cases* 26–34; Professor John Morley for helpful suggestions; Miss D. Davison for the drawings; and Mr. G. Kilshaw for the photographs.

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VASCULAR LOOPS IN THE APPENDICES EPIPLOICÆ

THEIR ANATOMY AND SURGICAL SIGNIFICANCE, WITH A REVIEW OF THE SURGICAL PATHOLOGY OF APPENDICES EPIPLOICÆ

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THE appendices epiploicæ are situated like flags marking the course of the ' vasa recta longa ' on the colon wall, that is, the vessels which come off the ' marginal artery ' and run to supply the colon. The slender artery (or less often two arteries) which supplies the appendix itself comes off the vas rectum longum on the colon wall, and runs its course as an end artery to the tip of the appendix. Jean Meillère (1927) in his detailed study of the vascularization of the coats of the left half of the colon and its surgical application, noted this constant relationship of the vasa recta of the colon to the bases of the appendices epiploicæ. " C'est sur le trajet des vaisseaux droits longs, et près de la bandelette distale que sont implantés les appendices épiploiques." He stated that in his injections, more often than not these vasa recta described a loop in the base of the appendix, 5 to 10 mm. or even more from the intestine. He noted, also, if he injected after ' disinsertion ' of an appendix epiploica level with the surface of the colon, then the triangular zone with its base at the free border and its summit at the mesocolic border supplied by the underlying vas longum was not injected. " La forme du territoire des vaisseaux longs explique bien les zones de gangrène observées après certaines enterorraphies circulaires." These observations of Meillère were referred to by Sir John Fraser (1938) in his review of the surgery of the colon.

If this observation of arterial loops in the appendices epiploicæ confirmed a common but little recognized formation, then one would expect to find further references to it by other authors. A search with this objective entails a review of the now quite considerable literature on the appendices epiploicæ. The most comprehensive papers are those by Briggs (1908), Harrigan (1917), Hunt (1919), Klingerstein (1924), Patterson (1933), Fiske (1936), Walser (1939), and Milroy Paul (1942). Rankin, Bargen, and Buie (1932) devote a whole chapter to diseases of the appendices epiploicæ in their book on the colon, rectum, and anus. These authors give details about the anatomy and pathology of appendices epiploicæ, and the clinical manifestations consequent on their disorders. They quote from less readily accessible papers by French, Italian, German, and Scandinavian authors. Of these, the thesis of Robinson (1908) on the anatomy and pathology of the ' sero-appendices ' is the most frequently referred to.

Torsion of the appendices is the commonest pathological change encountered. In sixty recorded cases of surgical affections of the appendices epiploicæ, all but six were instances of torsion (Le Vay, 1941); and Giffin, McManamy, and Waugh (1942), who reviewed the 178 cases of anomalies of epiploic appendages encountered at the Mayo Clinic from 1919 to 1941, stated that torsion undoubtedly initiates the great bulk of pathologic changes. Acute torsion produces obstruction of the blood-supply of the appendix, with consequent strangulation and gangrene; gangrene of an appendix epiploica may occur, however, without torsion, due to embolic or thrombotic cause (Randall, 1932).

More gradual torsion produces saponification of the fat of the appendix epiploica, and sometimes subsequent calcification. The pedicle becomes very narrow, and may necrose, thus setting free the appendix epiploica, which drops into the general peritoneal cavity, forming a loose fibrofatty or fibrocalcareous body (corpus alienum adiposum). This aspect of the pathology of the appendices epiploicæ has been described particularly by Harrigan (1917) and Hunt (1919) (each of whom give full historical reviews) and more recently by the present author (Ross and McQueen, 1948).

Torsion usually occurs in persons more or less obese during middle life and later (Briggs, 1908). The cause of the torsion is still obscure. Venous engorgement in physiologic splanchnic plethora is considered a predisposing factor (Pines, Rabinovitch, and Biller, 1941). The vein of the appendix, distended with blood, tends to twist around the artery, and so becomes obstructed and more engorged. This ' hæmodynamic torsion ', according to Payr (1902), is the determining factor in torsion of the appendices epiploicæ. Morestin (1912) stressed the point that unusual length and size of the appendices is essential for initiating torsion (he noted torsion in an appendix epiploica 15 cm. long), and most of the cases reviewed in the literature confirm his findings. It seems likely that a large congested appendix is in a condition peculiarly liable to become twisted round by bowel movements or some sudden strain on the patient's part.

An appendix epiploica may become adherent to the fundus of a hernial sac and become strangulated (Fitzwilliams, 1922) or drag on the colon, causing partial strangulation and giving rise to hæmorrhage from that part of the bowel after its escape (Smith, 1923). Appendices epiploicæ may cause intestinal obstruction in various ways, most commonly by adhesions connecting them to a loop of bowel or to a neighbouring appendix, and so obstructing like a band (Moore, 1940; Baumeister, Hargens, and Morsman, 1938; and McIver, 1933). Harte (1943) presents the case-history of a patient suffering from chronic partial intestinal obstruction caused by the intussusception of an epiploic appendix into the sigmoid colon in a man aged 56, and Gilchrist and David (1943) describe five specimens where carcinoma metastases were present in lymph-nodes found in appendices epiploicæ.

Appendices epiploicæ are frequently related to diverticula of the colon. McGrath (1912) considered that this relationship is " due to the fact that the

appendices epiploicæ are situated either directly on or close to the points where the larger vessels enter the intestinal wall "—that is, the point of weakness on the colon wall where diverticula arise, as Hamilton Drummond clearly pointed out (1917). Another reason for this close relationship was given by Telling (1908): "The point of their attachment to the gut is a 'locus minoris resistentiæ'. In a majority of cases the affected appendices are, or have been, filled with a large amount of fat. Bland-Sutton has stated '. . . that this fat is directly continuous with the subserous fat. If there is the slightest tendency to the formation of diverticula it will readily be seen that the soft fatty tissue of the appendix forms a point of lowered resistance.'"

Bland-Sutton (1903) also drew attention to the condition of a local inflammatory swelling in relation to the large intestine which proves to be an abscess in an appendix epiploica. The abscess is caused by the penetration of the intestine by a small ingested foreign body, the entry into the appendix epiploica preventing a perforation into the general peritoneal cavity. He described two cases he had operated on successfully and illustrated his article with excellent diagrams. Greaves (1914) described the condition in a woman operated on for gall-stone ileus, where two appendices epiploicæ of the pelvic colon were each found to contain a hard fæcal concretion the size of a large pea, no communication with the bowel being made out. He removed these concretions and the patient's pain in the left iliac fossa, which had been present for some years, disappeared.

Surgical affections of appendices epiploicæ are not recognizable as clinical entities pre-operatively, as the symptomatology is so indistinct. Up to the present time, only one case of intra-abdominal torsion has ever been diagnosed correctly pre-operatively. This was by Dr. W. Wayne Babcock, as described by Fiske (1936). Torsion of an appendix epiploica may simulate appendicitis (Hartley, 1922; Robertson, 1923; Palmer and Hardman, 1931; and Moore, 1942) or may be a cause of left-sided abdominal pain (Colt, 1932; and Byberg and Lam, 1945). The case may present as a strangulated inguinal hernia (Adler, 1908), an internal intestinal obstruction, an acute abdomen of indefinite aetiology, believed to have the primary focus in the gall-bladder, appendix, or pancreas (Rankin, Bargen, and Buie, 1932), or at laparotomy for obscure abdominal pain (Taylor, 1931). Calcified appendices epiploicæ are not merely radiological curiosities—they may influence differential diagnosis. Barden (1939) reports the case of a young man with abdominal pain, tender in the right lower quadrant of the abdomen. A radiograph showed two oval calcifications in the line of the right ureter in the pelvis, but retrograde pyelography showed they were not ureteric calculi. At laparotomy, when a subacute retrocæcal appendix was removed, the two oval calcified foreign bodies were found free in the pelvis. There was enough partially saponified fat adherent to them to justify the pathologic diagnosis of calcified epiploic appendages.

There is no case recorded as having first presented with the symptoms of peritonitis associated with perforation of a necrosed part of the intestinal wall due to torsion of an appendix epiploica interfering with the blood-supply.

Mabrey (1940) summarized the four cases, recorded in the literature up till 1940, where the cause of death was definitely related to the torsion of an appendix epiploica. Two of these were due to intestinal obstruction caused by appendices epiploicæ, one (a case of Riedel's) was due to general peritonitis, caused by *B. coli*, a culture of which was obtained from a fatty corpus alienum; and in one case, described by Ebner (1909) death occurred on the seventh post-operative day, and was due to paralytic ileus. Ebner explained the intestinal paralysis as being due to the coagulation processes in the mesenteric vessels following torsion of the appendix epiploica. This is the only case in the literature reviewed where interference with blood-supply of the colon due to torsion of an appendix epiploica is mentioned. The interference was considered to be a coagulation (thrombotic) process, not inclusion of a loop of a colon vessel in the torsion with ensuing gangrene of the colon wall. None of the other authors noted any change in the vascularity of the colon in relation to the affected appendices, either before or after operative removal by ligation at the base of the appendix, and no untoward effects on the bowel were noted as a result.

A recent case of the present author confirms their findings.

CASE REPORT

A woman, aged 47, was admitted to the wards in the charge of Mr. W. W. Carlow in Leith Hospital on June 30, 1948, with the history that a swelling in the left groin, which she had had for several months, had become hard and painful the night before. She had not vomited, but had felt some nausea and pain across the lower abdomen. On examination she was found to be moderately obese with a small tense irreducible femoral hernia. Operation was decided upon.

Under spinal anæsthesia (Dr. Bannerman) a horizontal incision was made over the swelling, which was exposed below the inguinal ligament, and the diagnosis of femoral hernia was confirmed. The inguinal canal was opened, and the sac delivered above the inguinal ligament, and opened (Lotheisen-Parry operation—Grey Turner, 1934). The content was found to be a large appendix epiploica of the pelvic colon; the appendix epiploica was swollen and deeply plum-coloured; no actual torsion was demonstrated. The narrow base of the appendix was transfixed with a linen suture and the appendix was removed flush with the colon wall. No vascular loop was noted at its base, and no colour alteration of the colon wall was visible after its removal. The neck of the hernia sac was transfixed and the sac removed. The conjoint tendon was then sutured with silk stitches down to the pectineal ligament (Astley Cooper), the inguinal canal closed, and the femoral ring closed with a silk mattress suture. A small drain was inserted via a stab wound in the lower flap, and the wound closed with interrupted silkworm-gut stitches.

The patient made an uninterrupted recovery. Her stitches were removed on the ninth post-operative day, she was allowed up on the tenth day, and went home on the fourteenth day.

Prior to this case, during the course of a study of vascular patterns in the Department of Anatomy of the University of Edinburgh, I had examined the blood-supply of twenty-six colons from subjects of ages ranging from infancy to old age. The relationship of the appendices epiploicæ to the vasa recta was investigated and in several instances the bases

of the appendices epiploicæ were ligated flush with the colon wall before injection with 6 per cent celloidin in acetone stained with alkanin. It was found that in some of the more obese subjects the vasa recta longa took a slight bend in the subserous fat at the base of the appendices epiploicæ, and in some cases the bend was marked enough to form a curve or wide arch, the vessel being raised off the colon wall in the fat one or two millimetres at the most. From the convex side of the curve the slender vessels supplying the appendix itself arose. In no instance was the arch prominent enough to form a loop in the appendix epiploica such as could have been involved in a torsion of an appendix. These findings were comparable with those of Pines, Rabinovitch, and Biller (1941), who state: "Vessels to the large bowel . . . divide at the mesenteric border of the colon within the peritoneal fat, then they encircle the wall of the bowel subperitoneally giving off small branches to the wall. In doing so they carry along a layer of protective subserous fat which is directly continuous with the fat in the mesentery. The main vessels continue into the fat of the appendices epiploicæ where they generally describe an inverted U-shaped arch from which branches run into the intestinal wall proximally and into the epiploic fat distally. The main vessel finally enters the intestinal wall adjacent to the border of the tænia. It therefore appears that the appendices epiploicæ are merely protective fat pockets for the redundant intestinal vessels when the intestinal wall is collapsed. This safety mechanism of vascular redundancy is obviously necessary to prevent compression of the vessels and obliteration of their lumens when the bowel is distended".

CONCLUSIONS

A review of the literature on appendices epiploicæ, the operative findings in a case of incarceration of an appendix epiploica in a hernial sac, and a study of the vascularization of twenty-six colons, all show that involvement of the colon vessels in affections of the appendices epiploicæ (especially torsion), with consequent gangrene of the colon wall, is very rare.

In only one instance (Ebner's case) is mention made that the blood-supply of the colon was considered to have been interfered with from torsion of an appendix epiploica, and this interference was a coagulative process in the mesenteric vessels, not a strangulation of a vascular loop.

The vessels of the colon wall (vasa recta) on their way around the intestine may take a curve, or wide U-shaped arch in the subserous fat at the base of the appendices epiploicæ, to make allowances for expansion of the colon; but a loop such as Meillère describes, sufficiently prominent to become involved in torsion of an appendix epiploica, has not been encountered.

It would seem that when torsion occurs in those cases where there is a vascular arch at the base of an appendix epiploica, the arch is too wide to become involved, and the vessel slips safely out of the way. Surgical removal of appendices epiploicæ by ligation at the base can be considered therefore quite safe. It is a reasonable precaution, however, as Sir John Fraser (1938) pointed out, to avoid being unduly radical when excising them, and in particular to avoid pulling the appendix away from the bowel before severance.

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DUMB-BELL GANGLIONEUROMATA

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ALTHOUGH the pathology of ganglioneuromata has excited much interest, these tumours are not common, and judging from the available literature the incidence of such tumours presenting with dumb-bell characteristics is rare. A case occurring in a child aged 3 years, with paraplegia, therefore warrants description.

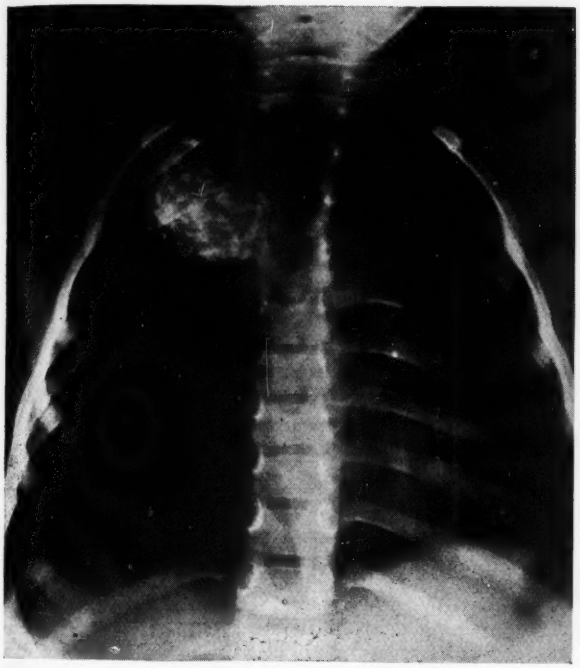

FIG. 590.—Postero-anterior radiograph.

FIG. 591.—Lateral radiograph.

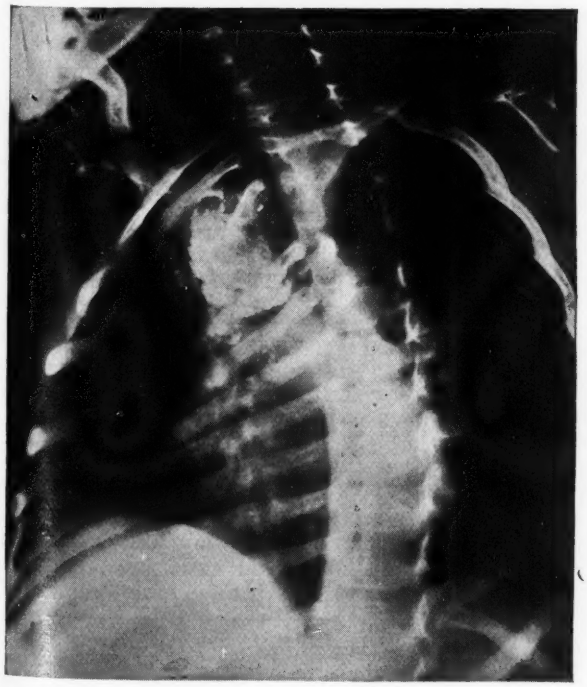

FIG. 592.—Left anterior oblique radiograph.

CASE REPORT

Gwenda, who was just under 3 years of age, was admitted to the Park Prewett E.M.S. Hospital, Basingstoke, in February, 1944, because of progressive weakness of the legs and trunk muscles. A history was obtained of fairly rapid onset of symptoms during the previous two months, the weakness commencing first in the left leg and later extending to the right.

Neurological examination (Dr. L. P. E. Laurent) revealed an almost complete paraplegia extending from the fourth dorsal segment. There was a rather angular kyphoscoliosis centred at about the same level, and a firm tumour mass could also be palpated deep in the musculature of the right erector spinatus.

X-ray examination of the spine and chest showed a large partially calcifying tumour in the right posterior mediastinum (*Figs.* 590–592). No appreciable erosion of nerve foramina or rib necks could be detected. In view of the signs of cord compression together with a paravertebral mass the diagnosis of dumb-bell tumour was made. There was no evidence of generalized neurofibromatosis.

FIRST OPERATION.—In May, 1944, a laminectomy was performed from D.3–5. A curved incision to the right was employed so as to facilitate the dissection, *en route*, of the tumour mass in the erector spinatus. The laminectomy revealed an extensive, smooth, lobulated extrathecal tumour situated mainly anterior to the cord and giving rise to gross compression of the latter structure (*Fig.* 593). After sacrificing the fourth dorsal nerve on the right side, the tumour was dissected without

undue difficulty except for a localized area of firm adherence to the posterior aspect of the fourth vertebral body requiring sharp dissection with the knife. This latter area gave rise to some concern at the time of the operation as to the benign nature of the tumour. It was found that

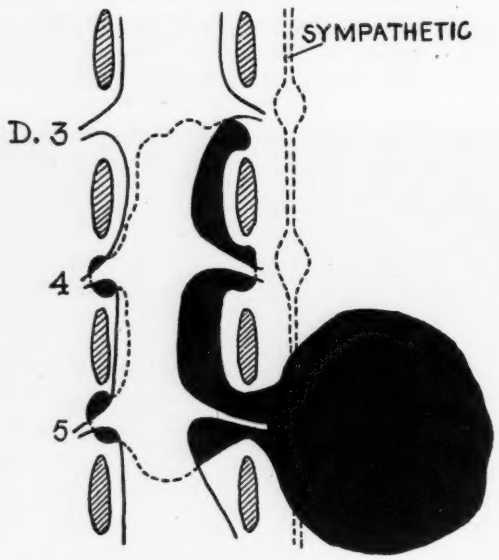

FIG. 593.—Diagrammatic representation showing the prolongations into the neural foramina.

the tumour was connected with the main paravertebral mass via the right fifth neural foramen (*Figs.* 593, 594) and it was decided to sever this connexion rather than attempt a complete enucleation in one operation. Small

FIG. 595.—The paravertebra tumour, showing cut surface and extensive calcification. The left-hand process communicates with the intraspinous portion through the fifth foramina; that at the top with the intramuscular mass. ($\times \frac{3}{5}$.)

prolongations were also found passing into the third and fourth foramina on the right side and into the fourth and fifth on the left (*Fig.* 593), but these were gently eased out with blunt dissection. The patient made a good recovery and by July was walking well with good motor and sensory recovery.

SECOND OPERATION.—In October, 1944, the paravertebral tumour was removed by an extrapleural approach through a right posterior mediastinotomy. This stage did not present any undue difficulties. No connexion with the sympathetic chain was demonstrated, but this was no doubt due to the limited exposure. In these days of controlled respiration anæsthesia, an open thoracotomy would no doubt be a better approach. The patient made a good recovery. The tumour is illustrated in *Fig.* 595. The kyphoscoliosis appeared somewhat increased and she was sent home with a light spinal support and a plaster bed for use at night.

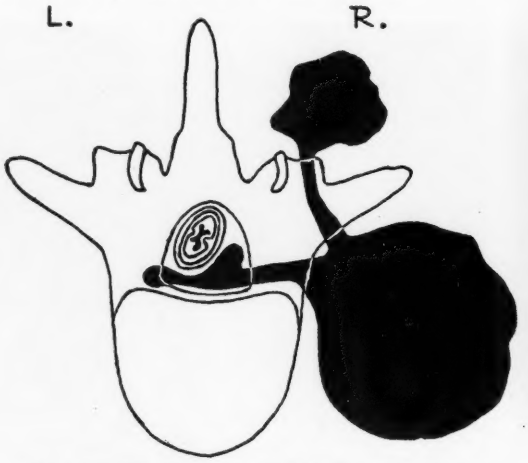

FIG. 594.—Diagrammatic representation of tumour, showing the connexions with the intraspinous portion and the tumour mass in the erector spinatus muscle.

PATHOLOGICAL REPORT (*Figs.* 596, 597).—The British Empire Cancer Campaign Pathological Sub-committee kindly provided the following report: "Ganglioneuroma. With Gross-Bielchowsky stain well-differentiated ganglion cells containing neurofibrils are seen, together with less-differentiated apolar neuroblasts. Dense tangle of axis cylinders forms much of the stroma, together with collagenous fibres (endoneurial sheaths). No evidence of myelin sheaths in fibres. (Spielmeyer's method used.) The tumour is likely to recur if removal is not complete, but the histology does not indicate any liability to malignant change."

FOLLOW-UP.—The patient was examined five years after her first admission to hospital and no evidence of any recurrence could be found.* There were signs of some residual spasticity of the legs with extensor plantar responses on both sides. The kyphoscoliosis was still present, but had not increased. On the advice of an orthopædic surgeon (H. H. Langston) the patient no longer wore the spinal support, but continued to use a plaster bed. She was able to skip, run, and cycle, and enjoyed the usual active life of a young schoolgirl.

The favourable histological report is borne out by the satisfactory five-year follow-up, and this case also gives some indication as to the prognosis to be anticipated in such a case where although there is a favourable pathological report, there are findings at the operation which may make the surgeon suspect its benign nature.

INCIDENCE

A study of the available literature reveals only seven previously reported cases of ganglioneuromata with dumb-bell characteristics, and only certain of these have had true intraspinous extensions, the others having only prolongations into neural foramina or

* The patient was demonstrated at this time before the Clinical Section of the Royal Society of Medicine. I wish to thank the Editor of the *Proceedings* for permission to refer again to the case.

between ribs to give rise to paravertebral masses in the muscles of the back.

Loretz (1870) described the autopsy findings of such a case occurring in a woman aged 35, who was admitted to hospital unconscious and who died before a history could be elicited.

Rapp (1913) gives an account of a boy, aged 4, who had increasing paresis of both legs, together with a large abdominal tumour in the left iliac fossa and a less well defined tumour in the right lumbar region. Partial removal of this latter tumour through a loin incision was performed and prolongations through the spinal foramina noted. The operation was followed by some partial recovery of the paresis. No attempt was made at a separate removal of the intraspinous portion of the tumour.

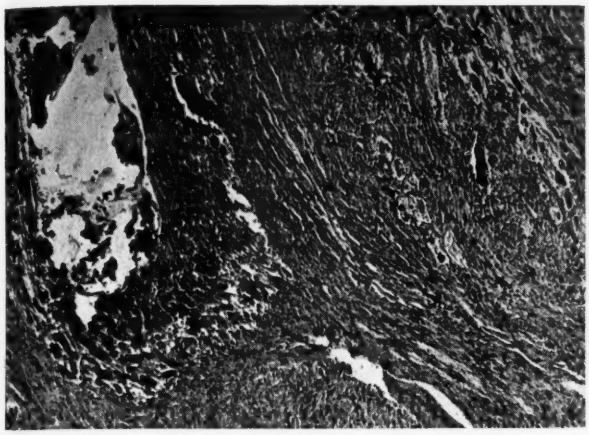

FIG. 596.—Showing a moderately cellular tumour with some calcification, and a stroma of non-myelinated nerve-tissue. Hæmatoxylin and eosin. (× 48.)

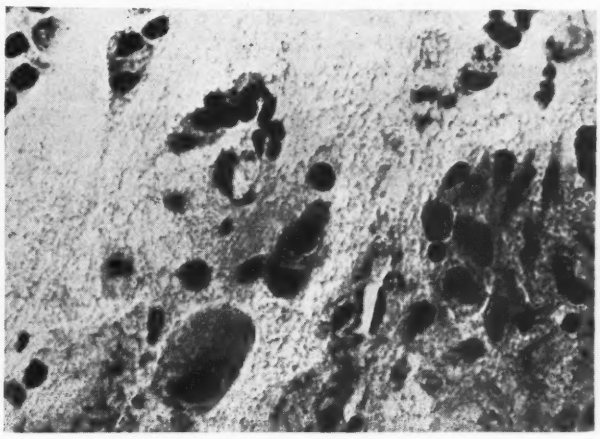

FIG. 597.—Showing a large ganglion cell, together with more primitive cells approximating to neuroblasts, and intermediate forms. Hæmatoxylin and Van Gieson. (× 500.)

Stout (1924) gives the account of a boy, aged 2½, who presented with paraplegia and a large tumour mass in the right upper mediastinum. A long encapsulated extrathecal tumour was removed at laminectomy, but the child unfortunately succumbed.

A most interesting case was described by Cushing and Wolback (1927) of a dumb-bell tumour occurring in a boy, aged 1 year 9 months, in whom a biopsy of a tumour mass in the paravertebral muscles revealed the pathology to be a malignant sympatheticoblastoma (originally diagnosed as a fibrosarcoma). The patient was treated with Coley's fluid by Dr. Coley himself, and the tumour mass regressed considerably although the signs of spinal compression persisted. Ten years later Cushing successfully removed an intraspinous tumour, the histology of which revealed it to be a ganglioneuroma. This case would appear to be a well-substantiated example of the transformation of a malignant tumour to a more innocent one. The authors do not comment on the part played by the Coley's fluid in this histological change.

Naffziger and Brown (1933) record a series of 15 'hour-glass' tumours, 1 of which was a ganglioneuroma occurring in a boy, aged 7, with paraplegia and an extensive paravertebral tumour. At laminectomy an extradural tumour was removed from the region of the third and seventh dorsal segments, but the symptoms of spinal block recurred and a second laminectomy two months later revealed that the tumour had re-formed locally. This was again resected but the patient subsequently died three months later. Autopsy revealed yet further local recurrences. No attempt was ever made to excise the extraspinous part.

An exhaustive account of 'dumb-bell' tumours was given by the late Kenneth Eden in his Hunterian Lecture, and later published in this JOURNAL (Eden, 1940). He reviewed 234 cases of spinal tumour collected over twenty years at the University College Hospital and the National Hospital, Queen's Square, and found 32 to be dumb-bell in character. The pathology of these proved to be usually solitary or multiple neurofibromata: and only one to be a ganglioneuroma. This case occurred in a male, aged 23, who had paraplegia extending from the fifth dorsal segment. He was subjected to a thoracotomy but extensive extraspinous tumour formation precluded removal. The patient later died and the post-mortem findings are described in detail.

Paterson and Pilcher (1940) give a case report of a ganglioneuroma occurring in a boy, aged 4, who had a large rounded tumour in the right upper posterior mediastinum. There were no signs of any intraspinous tumour formation, although at operation a small prolongation into the fourth neural foramen was found together with larger extensions into the fourth and sixth intercostal spaces. The tumour was successfully removed and was found to be in part cystic and necrotic.

CLINICAL FEATURES

Although few cases have been described there are certain features common to all, so that a correct pre-operative diagnosis should be a possibility. The following are the helpful features:—

1. **Age.**—As pointed out by many workers, ganglioneuromata are tumours of early childhood, especially between the ages of 2 and 5 years. This fact is of interest when considering the mode of dumb-bell formation (*see below*).

2. **The Paravertebral or Extraspinous Component.**—This would seem to be more commonly

found in the upper thoracic region and presents as a posterior mediastinal shadow on radiography. The tumour is often silent, but may give rise to symptoms suggestive of primary lung disease (Paterson and Pilcher, 1940). Care must be taken to differentiate the shadow from a tuberculous paravertebral abscess, which is strongly suggested in cases presenting with paraplegia and localized kyphoscoliosis. Dumb-bell tumours with extraspinous portions in the abdomen or neck have invariably proved to be neurofibromata. As in the case here described, there is often a prolongation of the extraspinous mass between the necks of the ribs to give rise to a palpable tumour deep in the substance of the paravertebral muscles. Special radiographic studies should be carried out in all suspected cases of dumb-bell tumour in order to verify the existence of any erosion of the rib necks or intervertebral neural foramina.

3. The Intraspinous Component.—Signs of spinal compression would appear to be fairly constant findings and are due to an extradural tumour situated anterior to the cord and extending upwards or downwards for a variable distance. It communicates with the extraspinous portion by processes passing through one or more neural foramina; and in this situation would appear to have intimate association with the issuing nerves. However, histological studies reveal no medullated nerve-fibres, proving that such tumours have no developmental association with the segmental nerves. Even in the absence of paraplegia it is important to have constantly in mind the possibility of an intraspinous extension when operating on tumours of the posterior mediastinum. Failure to recognize this possibility has led to leakage of cerebrospinal fluid from damage to the dural envelopes that surround the issuing nerves (Naffziger and Brown).

Scoliosis.—Numerous workers have drawn attention to the incidence of scoliosis in generalized neurofibromatosis and its aetiology has given rise to much speculation. Although such deformity may occur in the absence of any dumb-bell tumour, Eden drew attention to its frequent coexistence with dumb-bell neurofibromata and advanced the simple explanation that it was in such cases a result of the associated bony destruction; or, failing that, a change of tonic nerve control to the spinal musculature, as first suggested by Parkes-Weber (1930). A similar kyphoscoliosis confined usually to the upper dorsal region would appear to be a fairly constant finding in dumb-bell ganglioneuromata, and can no doubt be explained on similar grounds. The illustration of Eden's case shows the extensive scoliosis that was present.

Remittance of Paraplegic Symptoms.—In the case described by Eden symptoms suggestive of cord compression had occurred at the age of 5, but had cleared up spontaneously after a few years, only to become manifest again at the age of 23. Eden believed this chain of events was due to spontaneous decompression of the cord resulting from erosion of the pedicles and neural foramina, followed by persistent growth of the intraspinous tumour with recurrence of compression. However, consideration of the case described by Cushing and Wolback, and to a lesser extent that by Naffziger and Brown, would suggest that a more likely explanation lies in the possibility that some of these tumours are at first malignant in nature and later become, with the growth of the host, more differentiated. A further factor may be a disproportionate increase in the rate of growth of the spinal column at this actively growing age as compared with the rate of growth of the enclosed tumour. Wahl (1914) and Dunn (1915) have shown that these tumours arise from the sympathetic system, and Willis (1948) emphasizes that all tumours developing from the sympathetic anlage are to be considered as a group, and although some may be obviously malignant (neuroblastoma) and others relatively benign (ganglioneuroma) there are numerous grades between these two extremes, and that it is often difficult accurately to assess the true nature of any one particular tumour. Robertson (1915) describes the occurrence of such tumours of intermediate, transitional, or mixed histology and calls them 'ganglioneuroblastomata'. The origin of this group of tumours from the sympathetic anlage is of especial interest when considering the mode of dumb-bell formation. It is probable that these tumours commence neo- or pre-natally before or during the migration of the sympathetic system laterally from the neural crest (i.e., are dysontogenetic), and that the dumb-bell shape results from the formation of the vertebral column around the tumour; rather than prolongation of the tumour into the foramina. If these tumours commence at such an early age, when the developing sympathetic cells are of the most primitive type, it would seem reasonable to argue that all such tumours at some time in their history are 'neuroblastomatous' in nature, and later may, and in fact usually do, become more differentiated to ganglioneuromata. Thus the younger the subject the more likely the tumour is to be malignant. It is interesting to note, however, that the recurring tumour described by Naffziger and Brown was in a child aged 7—rather older than the average. The calcification occurring in the case reported above is of interest, as it would appear to be unique, and also, because of its fairly extensive nature, lends support to the opinion that the tumour had been present for a considerable time and is quite likely, in view of the child's age, to be neonatal in origin.

SUMMARY

1. A case of a ganglioneuroma presenting as a dumb-bell tumour in a girl, aged 3, is described. There was present an extensive paraplegia resulting from an intraspinous extrathecal component. A large mediastinal mass and a small mass in the erector muscles were also present.

2. The successful removal of the tumour in two stages is described.

3. A satisfactory five-year follow-up is reported.

4. A brief summary of previously reported cases of ganglioneuroma with dumb-bell characteristics is given.

5. An attempt is made to evaluate the symptomatology and physical signs so that a correct preoperative diagnosis might be made with similar cases in the future.

6. The mode of origin and the pathology of such tumours, together with their relation to neuroblastoma, is discussed.

I wish to acknowledge my indebtedness to Dr. L. P. E. Laurent and Mr. H. H. Langston for referring the case to me for surgical treatment. My thanks are also due to Dr. Roger Pugh for the photomicrographs; to Dr. J. L. Feuchtwanger for the radiographs; and to Dr. P. N. Cardew, of St. Mary's Hospital Photographic Department, for the photographs.

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SHORT NOTES OF RARE OR OBSCURE CASES

ECTOPIA VESICÆ IN AN ADULT WOMAN

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ECTOPIA vesicæ, according to Neudorfer (1886), occurs once in every 50,000 births; and Lowsley and Kirwin (1944) state that only one case in six is of female sex. Mayo and Hendricks (1926) have shown that of untreated cases 66·67 per cent are dead by the twentieth year. It follows that an adult woman suffering from untreated ectopia vesicæ is of great rarity; and, if only for that reason, it is felt that the following case is worth recording.

In perusing the literature the writer was impressed by the comparative infrequency with which reference was made to the method of closing the defect in the abdominal wall following excision of the ectopic bladder; and the opportunity has been taken to describe the method used in this case.*

CASE REPORT

HISTORY.—The patient was born twenty years ago in a country district. The parents lived on an isolated farm fifteen miles from the nearest town. The doctor who attended the birth, and who subsequently referred the patient to the writer for treatment, noted the deformity and recorded that there appeared to be no vagina. The child was therefore registered as a male. At the age of 1 year it was taken to a children's hospital for operation; but was sent home untreated because of a whooping-cough epidemic.

She was not seen again by her doctor until the age of 18 years, when a minor respiratory ailment was treated; no mention being made of the deformity which the doctor had long since forgotten.

She was seen again at the age of 24 years because of a nervous upset, and with a great deal of diffidence submitted to a general examination. The deformity was, of course, rediscovered, and the doctor was immediately impressed by the patient's female habitus. For twenty years she had gone about as a boy and man, wearing trousers, and doing hard manual work on a dairy farm. She had never learned to read or write. Over the years the doctor had regularly attended the other five children in the family, but out of some mistaken sense of shame the condition of the patient was concealed from him. When the mother was told that her child was not a man but a woman, she agreed, and said she had come to the same conclusion years before, and especially since the onset of normal and regular menstruation.

ON EXAMINATION.—The patient was of small stature with a forward stoop, rounded shoulders, and a characteristic gait. Loose-fitting male clothing concealed a large urine-soaked towel worn as a diaper, and concealed the breasts.

She had fine features, a girlish voice, and her mannerisms were essentially feminine. Although completely illiterate she seemed otherwise intelligent, but somewhat timid and moody. There was a surprising absence of urinous odour.

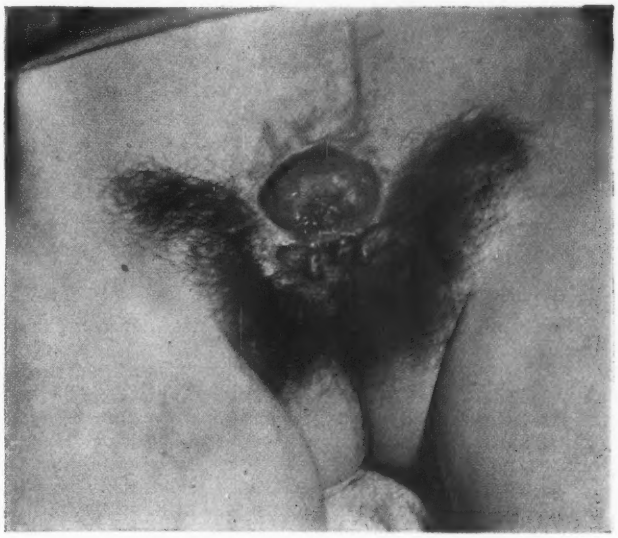

FIG. 598.—Ectopia vesicæ in an adult female. Note the umbilical scar at the upper margin of the bladder and the scar following transplantation of the ureters into the colon. The double vaginal orifices lie between the labia minora. The wide crutch is well shown.

The appearance of the exposed bladder is well seen in the coloured photograph (*Fig.* 598), and the widened crutch will be noted. The umbilical scar is discernible at the upper margin of the defect. The bladder wall was flaccid in recumbency, but immediately everted in the erect position. The mucosa was red, thickened, easily abraded, and constantly wet. The ureteric

* Demonstrated in Adelaide at a meeting of South Australian Fellows of the Royal Australasian College of Surgeons, July 24, 1948.

orifices were not dilated and the trigone was continuous with a shallow vulval cleft. The clitoris was absent and the labia minora widely separated.

At first sight there appeared to be no vagina, but on closer scrutiny two small vaginal openings discharging mucus could be seen. The photograph happened to be taken during menstruation, and blood-clots are visible on the vulval cleft. The anus gave the impression of being more anterior than normal, but the sphincter was efficient in every respect.

The pubic bones were separated by a gap of 6 in., and the recti could be seen and felt diverging accordingly.

A radiograph (*Fig.* 599) emphasized the extent of the pubic separation, and an intravenous pyelogram showed

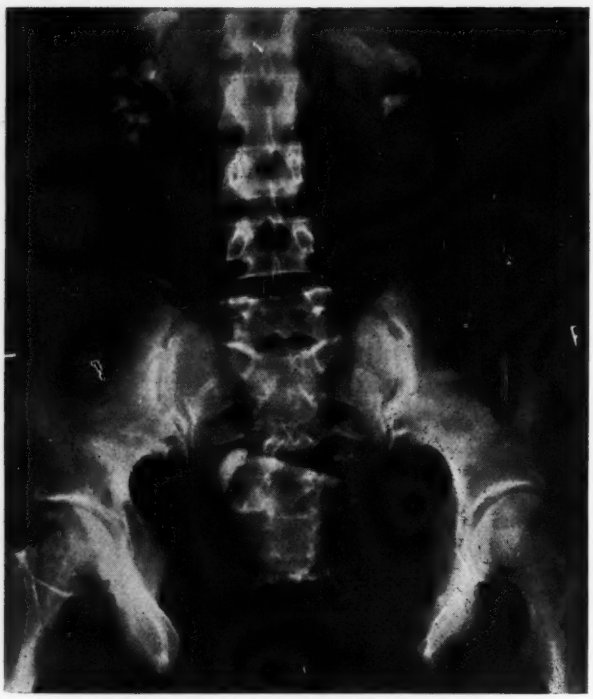

FIG. 599.—Radiograph of ectopia vesicæ in an adult female. Note the wide separation of the pubic bones.

normal renal pelves. Visualization of the ureters, however, proved impracticable.

The blood-urea nitrogen was 12 mg. per cent, and the urine was macroscopically clear.

TREATMENT.—On March 1, 1947, following three days' preparation with succinyl sulphathiazole and vitamin K, the abdomen was opened under light percaine spinal anæsthesia, and ureters of normal calibre having been exposed transperitoneally they were anastomosed to the lower sigmoid by the Coffey I technique. It was noted that a well-developed uterus was present. A rectal tube was left in position for twenty-four hours, and 2 l. of intravenous saline were given. Sulphacetamide and succinyl sulphathiazole were continued for four days.

Ten ounces of urine were voided in the first twelve hours, and the further post-operative course was uneventful. The patient went to her home in the country on April 23, 1947.

On Nov. 2, 1947, she returned for completion of treatment. She was much more cheerful and had already begun to attend church and the cinema. Continence was complete, urine being voided by day at intervals of two and a half to three hours.

Sterilization by deep X rays was then carried out. This was in accordance with the patient's desire to continue life as a male, and removed the embarrassment of menstruation.

On November 20, 1947, the thick-walled bladder was excised by a circular incision, leaving behind a triangular portion of the trigone (*Fig.* 600). The ureters were divided and ligated.

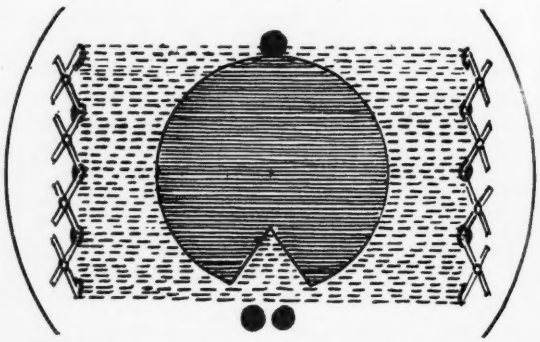

FIG. 600.—Cystectomy and repair of the abdominal wall. The lines represent the incisions made; the shaded area the sheet of fascia lata, and the black spots the umbilicus and double vaginal openings respectively.

A curved incision 6 in. long was made 3 in. from each lateral margin of the defect, and the skin was extensively undermined. The musculofascial hiatus was closed by means of a piece of fascia lata 7 in. by 3½ in., each end being cut into eight strips as in a many-tailed bandage. The fascial sheet was placed deep to the muscles and the tails were brought through the lateral borders of the recti and through the anterior rectus sheaths. On each side the eight tails were knotted in four pairs, the knots being rendered secure by fine silk sutures.

The medial skin-flaps were approximated and sutured in the midline, the lateral margins of these flaps being left unsutured (*Fig.* 601). The two secondary defects

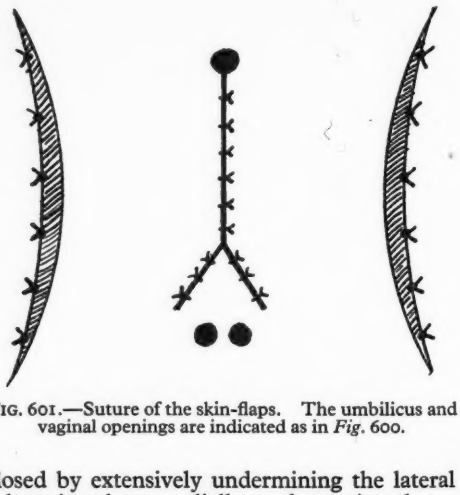

FIG. 601.—Suture of the skin-flaps. The umbilicus and vaginal openings are indicated as in *Fig.* 600.

were closed by extensively undermining the lateral skin-flaps, advancing them medially, and suturing them to the aponeurosis but not to the medial flaps. Penicillin and sulphadiazine were given post-operatively.

The immediate post-operative course was uneventful and healing occurred satisfactorily without sepsis and without any loss of the graft (*Fig.* 602).

Convalescence, however, was interrupted by an attack of right-sided pyelitis, and a shorter attack affecting the left kidney. An intravenous pyelogram on Feb. 5, 1948, showed a slight degree of hydronephrosis on each side and delayed secretion on the right side (*Fig.* 603). The blood-urea nitrogen on Feb. 10, 1948, was 16 mg. per cent. On the completion of convalescence she returned to the country on March 26, 1948, to continue life as a male worker on her mother's dairy farm.

COMMENTS

There were two imperative reasons for excision of the bladder: first, deviation of the urine did not lessen the sensitiveness of the exposed mucosa; and secondly, the risk of carcinoma in an extroverted bladder had to be considered. It is of interest

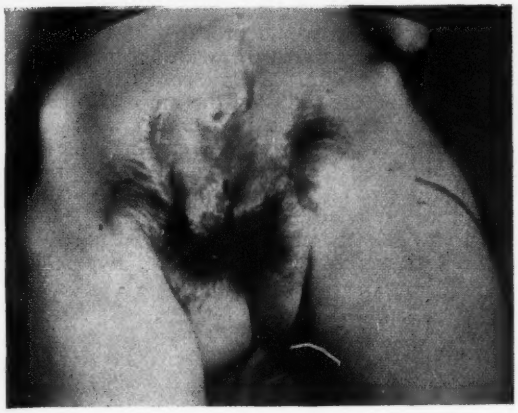

FIG. 602.—Final appearance following cystectomy and repair of the defect. The scar on one thigh marks the source of the sheet of fascia lata.

to note that of 26 cases of carcinoma complicating ectopia vesicæ reviewed by Graham (1942) the vast majority were adenocarcinomata.

In this patient the problem requiring most thought was the repair of the rigidly circular hiatus in the abdominal wall, associated as it was with wide separation of the lower ends of the recti and pubic bones. It was desired, if possible, to avoid a multistage procedure, and it is felt in retrospect that the employment of a sheet of fascia lata was eminently satisfactory. Doubts were felt, however, because of the impossibility of securing an aseptic field. Closure of the skin without grafting required careful planning of the flaps.

Other Methods of Closure of the Abdominal Wall.—In a child closure of the abdominal wall can be effected by approximation of the margins of the defect (Dodson, 1944).

In an adult, however, simple suture is not so readily applicable. Young and Davis (1926) described the use of over-lapping mediaily hinged rectus-sheath flaps; and more recently Young (1942) has reported a slight variation of the same method used in the first recorded successful case of reconstruction of bladder and sphincter in ectopia vesicæ.

Pickerell and Pickerell (1945) supplemented crossed rectus-sheath flaps by a pedicle graft to replace the cutaneous defect.

There seems to be no doubt that the use of rectus-sheath flaps is the method of choice in average circumstances, but in the case presented the amount of material available would not have provided sufficient overlap.

SUMMARY

1. A case of ectopia vesicæ in an adult female is reported.

2. The vagina was double and the cervix and uterus were presumably septate.

3. Treatment was carried out in three stages: (*a*) Transplantation of the ureters into the colon;

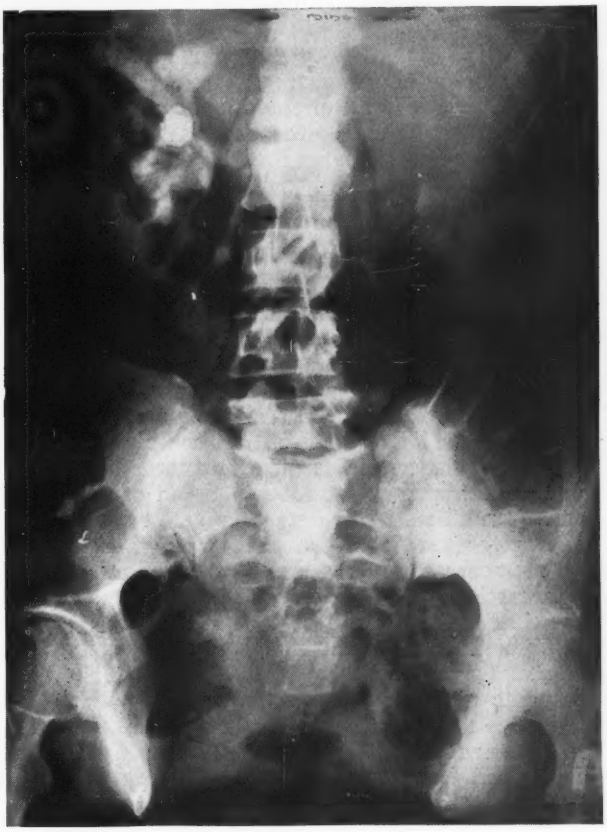

FIG. 603.—Intravenous pyelogram eleven months after ureterosigmoidostomy, showing slight hydronephrosis on each side.

(*b*) Sterilization by deep X rays; and (*c*) Cystectomy with repair of the defect using a sheet of fascia lata.

4. The patient continued to live and work as a male.

My indebtedness to Dr. C. E. King, from whose clinical notes I have quoted freely, is acknowledged with pleasure; and my thanks are due to Mr. Darian Smith for the excellent coloured photographs.

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ADENOCARCINOMA OF THE UPPER END OF THE ŒSOPHAGUS ARISING FROM ECTOPIC GASTRIC EPITHELIUM

By ALAN CARRIE, Toronto

The majority of œsophageal carcinomas are epidermoid, as nearly all of the œsophagus is lined by stratified squamous epithelium. Glands of two types, however, may be found in it. There are always some irregularly distributed submucosal mucus-secreting glands, and often some superficial ones resembling gastric glands, situated in the mucosa at the upper and lower ends of the œsophagus. Those at the lower end are common, occurring in a mixed zone of glandular and squamous lining between the stratified squamous epithelium of the œsophagus above and the glandular epithelium of the stomach below. Those at the upper end are more unusual, for they occur as isolated islands of ectopic gastric mucosa on the lateral walls of the œsophagus between the level of the cricoid cartilage and the fifth tracheal ring, and are present in about one-half of the specimens examined. Hewlett (1900) felt that these might give rise to adenocarcinomas, but, on reviewing the literature, found that none of the six cases of adenocarcinoma of the œsophagus reported up to that time had occurred at the upper end.

Since then, adenocarcinoma of the upper end of the œsophagus has become somewhat like a unicorn, for while the authors of most text-books state that this tumour does occur, they do not say that they have seen it themselves, and fail to state who did. Henke and Lubarsch (1931) quote White as having reported such a tumour, but their reference leads to an article on malaria. White (1898) did report a case of adenocarcinoma of the œsophagus, but this was at the lower end. Abel (1929) made no mention of adenocarcinoma of the upper end of the œsophagus. Ackerman and Regato (1947) doubted if adenocarcinoma of the œsophagus exists as a clinical entity. Feldman (1939) described an adenomatous polyp of the upper end of the œsophagus, which had become malignant, but did not discuss its relation to these patches of ectopic gastric epithelium. A survey of the 19 adenocarcinomas of the œsophagus that have been received by this department during the past fifteen years disclosed that none involved the upper end. Thus we felt that the following case, which microscopically shows an adenocarcinoma arising from a patch of ectopic gastric epithelium at the upper end of the œsophagus, should be reported.

CASE REPORT

A 64-year-old man developed difficulty in swallowing solid foods in June, 1948, and a biopsy taken from a lesion at the upper end of the œsophagus was reported as a benign adenoma. In December, œsophagoscopic examination revealed a firm mass 3 cm. below the cricopharyngeus. This had a granular grey surface, and almost completely filled the lumen. It was attached to the left lateral and posterior walls, and had the gross appearance of a carcinoma. A biopsy taken at this time was reported as benign adenoma. Dr. H. Wookey felt that, in spite of this pathological report, the lesion was probably malignant and he resected the upper portion of the œsophagus, using a skin-flap to reconstruct the lost portion. The patient is now alive and well, more than a year after the operation.

Report on Specimen.—

Gross Appearance.—A section of œsophagus 4 cm. long was received. It had been fixed in formalin, and so the original specimen would probably have been longer. In the middle was an area of firm thickening, 3 cm. in diameter and 0·9 cm. thick. The cut surface was a deep ivory colour. In the centre of the mucosal aspect was a roughened area 0·8 cm. in diameter.

Microscopical Appearance.—Replacing the normal stratified squamous epithelial lining and projecting slightly above it was a patch of columnar epithelium with the structure of pyloric glands (*Fig.* 604). Their cells were tall and pale-staining, with flattened basally placed nuclei. From the base of this patch, hyperchromatic

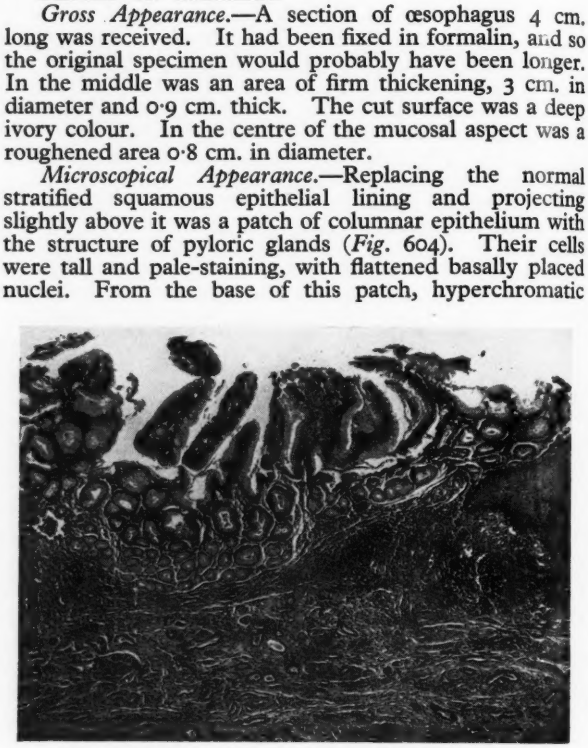

Fig. 604.—Ectopic pyloric glands with adenocarcinoma beneath them. H. and E. (× 30.)

malignant glands invaded the submucosa widely, and spread into the muscularis externa. Variations in cell size and mitotic figures further attested to the malignant nature of the lesion.

Comment.—From the microscopical sections it is easy to see why the biopsies were reported as a benign adenoma, for the superficial part of this lesion was composed of normal glandular tissue. The malignant glands were deep to it, spreading diffusely through the submucosa and into the muscular layer.

SUMMARY

A case is reported of an adenocarcinoma of the upper end of the œsophagus arising from ectopic gastric epithelium. This is, as far as we know, only the second case of adenocarcinoma of the upper end of the œsophagus in the literature.

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KNOT IN MECKEL'S DIVERTICULUM CAUSING ACUTE INTESTINAL OBSTRUCTION

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MECKEL'S diverticulum has been well known as a cause of intestinal obstruction since Sandifort (1793) described Van Doeveren's case. Of 1134 cases of intestinal obstruction analysed by Leichtenstern 67 (6 per cent) were due to the diverticulum. Halstead (1902) found the same percentage in 991 cases collected from the literature.

One of the least known ways in which obstruction may occur is strangulation of a loop of gut by a knot tied in a free Meckel's diverticulum. I have been able to find only 6 such cases, including the example recorded here, in the literature of the present century, although the condition would appear to have been much better known to earlier writers. (Of Leichtenstern's 67 cases, 12 were due to diverticular knots, and Treves, in his Jacksonian Prize Essay of 1884, remarked that the condition was not uncommon and described many examples from the London museums.)

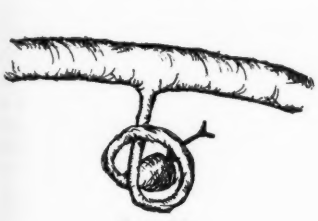

FIG. 605.

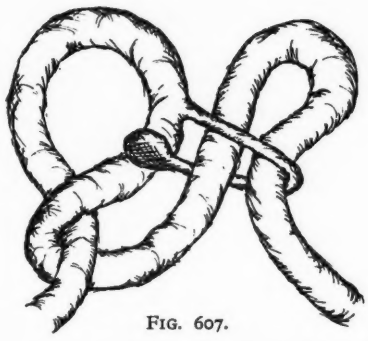

FIG. 607.

FIGS. 605–607.—Varieties of knot formation. (*Treves.*)

These remarkable knots and the methods of their formation were very exhaustively studied nearly a hundred years ago by Parise and later by Nothnagel (1898). Before such a knot can be tied the diverticulum must have three peculiarities :—

1. It must be unusually long.
2. It must be quite mobile and unattached, save for its origin from the ileum.
3. It should possess an ampulla at its distal end. The ampulla is of paramount importance, and by the French writers was called " *la clef de l'étranglement* ". Meckel's diverticulum is composed of all the layers of the small intestine and usually is cylindrical with a tapering, conical extremity, resembling closely a finger-stall. If, as sometimes happens, the muscle-coat is deficient at the apex the intraluminal pressure causes a bulging at this point, so that the free end of the process presents an ampulla of globular shape.

Treves described three varieties of knot formation :—

a. The diverticulum forms a ring into which its own free end projects (*Fig.* 605). A loop of intestine enters as shown by the arrow, pushes the clubbed end of the diverticulum before it, and so ties the knot by which the coil becomes obstructed.

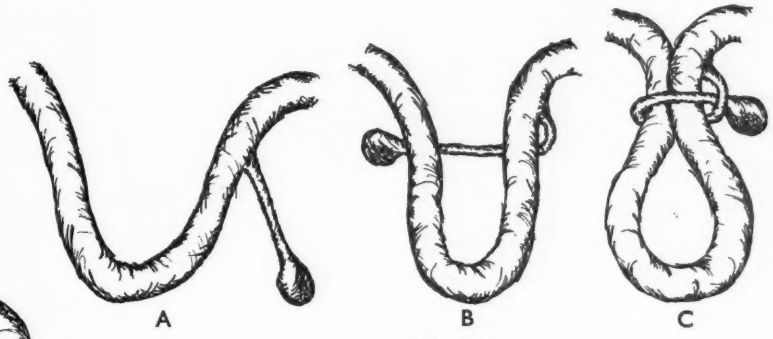

FIG. 606.

b. The diverticulum surrounds the pedicle of an intestinal loop so as to encircle it with a simple knot (*Fig.* 606). This type was described originally by Regnault in about 1840 and recently by Dorling (1941).

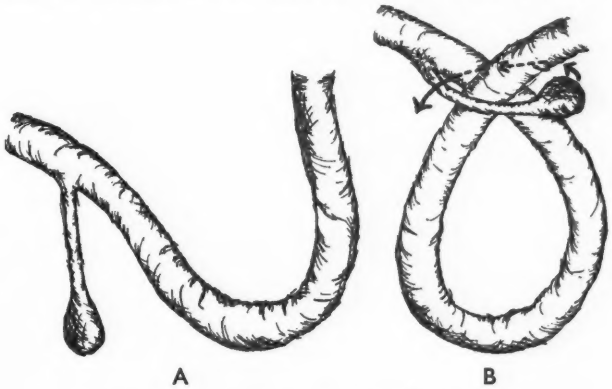

FIG. 608.—Stages in the commonest method of knot formation.

c. In this form two loops of bowel are involved, one above and one below the origin of the diverticulum (*Fig.* 607). One loop enters the knot by a preliminary rotation, the other is caught as in the simple knot. Only one case of this type has been recorded (Lévy, 1845).

Study of 19 cases from the literature reveals that the commonest mechanism differs in one important

detail from the varieties enumerated by Treves. Here the first step is a partial volvulus, through 180°, of a loop close to the base of the diverticulum. The narrow base of the volvulus is then encircled by the diverticulum (*Fig.* 608). This was the mechanism in the author's case and *Fig.* 609 is a sketch of the specimen as seen at operation.

FIG. 609.—A sketch of the specimen in the author's case as seen at operation. Note the partial volvulus and the ampulla on the diverticulum.

Many of the collected cases have had a history of several years of abdominal pain before the onset of the acute strangulation, suggesting that the partial volvulus may have been of long standing before the tying of the knot precipitated a crisis. Four out of six personal cases of simple volvulus of the small gut had a history of many years' dyspepsia, and in all four the patient was symptom-free from the time of resection of the volvulus. Little emphasis has been laid in previous writings on the occurrence of dyspepsia in chronic volvulus of the small intestine, but I hope to record and discuss these observations in a separate communication.

CASE REPORT

W. H. R., an engineer's fitter, aged 63, was admitted to the Royal Southern Hospital, Jan. 25, 1949, complaining of severe abdominal pain and backache.

HISTORY.—In 1940 his ship was torpedoed and he was the only survivor of six hours' immersion in very cold water. Since that time he had never been well and was able to work only intermittently, his chief complaint being abdominal pain about 20 minutes after almost every meal. On Jan. 22 he awoke at 2 a.m. with very severe pain in both loins. When seen by his doctor a few hours later he was shocked and collapsed, but had as yet no symptoms other than the acute backache. During the next 24 hours the pain shifted gradually to the abdomen, and on admission was centred chiefly at the umbilicus. He first vomited 36 hours after the onset of pain and thereafter whenever he took anything to drink. He described the vomitus as 'bile and coffee-grounds' and said that it was never more than half a cupful at a time. The bowels had not been opened for four days and there had been absolute constipation for 24 hours before admission. For two days he had noticed some discomfort on micturition.

ON EXAMINATION.—A pale, cachectic man of slight build, he looked ill and anxious and had severe hiccup. The tongue was moist, with a central white fur. T. 98·5°; P. 88; R. 28. The abdomen presented a considerable generalized distension, most marked centrally and below the umbilicus. Generalized tenderness and guarding were maximal in the epigastrium. Auscultation revealed a total absence of any peristaltic sounds, but the occasional tinkles typical of very distended small gut could be heard. On rectal examination a very tender cystic swelling was palpable in the rectovesical pouch. A plain radiograph of the abdomen showed grossly dilated coils of small intestine and many fluid levels, but no subdiaphragmatic gas.

A tentative diagnosis was made of paralytic ileus following perforation of a gastric ulcer and after instituting gastric suction and intravenous saline drip operation was begun.

AT OPERATION.—Anæsthetic (Dr. Rhind): Sodium thiopentone and *d*-tubo-curarine chloride supplemented by endotracheal nitrous oxide.

Upper midline incision. Very distended coils of small gut presented. The peritoneal cavity contained only a small amount of blood-stained fluid. The stomach was small and contracted, and it was quickly obvious that there was no peptic ulcer. On passing a hand into the pelvis an impacted cystic mass was felt. This was easily delivered and proved to be a partial volvulus of some 30 cm. of the lower ileum. Around its base was tied, in a tight and complex knot, a Meckel's diverticulum about 15 cm. long. This truly Gordian knot was impossible to untie and was so tight as almost to sever the involved loop, which was frankly gangrenous. The affected segment was rapidly resected. As soon as the resection was completed there was a marked improvement in the patient's general condition and an end-to-end anastomosis was made.

Post-operatively gastric suction was continued and intravenous fluids were given, controlled by blood-volume estimations and repeated blood analyses. Penicillin, 100,000 units 2-hourly, and sulphathiazole, 2 g. 4-hourly, were given into the drip. An attempt to pass a Miller-Abbott tube failed. The paralytic ileus persisted and the patient died on the ninth post-operative day.

A notable feature was the initial pain in the *back*. Back pain has occasionally been observed in acute abdominal catastrophes in which there is extensive involvement of the mesentery (Halligan and Halligan, 1937).

In conclusion, it is a privilege to record my thanks to Mr. Cosbie Ross for permission to treat and to record this case, and for his very helpful advice and criticism at every stage.

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NEURINOMA OF THE STOMACH

By LOUIS A. IVES, Isleworth

A case of neurinoma of the stomach is recorded. It illustrates the classical mode of presentation and the typical X-ray appearances, whilst histologically the tumour is an unusual type of neurinoma apparently peculiar to the stomach.

Fig. 610.—Gastroscopic view of the tumour.

CASE REPORT

History.—Mrs. Emily J., aged 43, was admitted to hospital with hæmatemesis. She had her first attack at the age of 30, thirteen years previously, and prior to the onset of the present episode she had had two or three further hæmorrhages spaced at intervals of some years. Between the bouts she felt perfectly well. The penultimate hæmatemesis occurred four years ago and since then she remained in normal health until two days before the present crisis, when she felt tired and lethargic. On the evening before her admission she had a late tea and was sitting in an armchair when she suddenly felt faint and ill. She went to lie down and soon vomited, bringing up about half a pint of blood and food.

On Examination.—A pale stout woman lying quietly in bed. Apart from her pallor, which suggested a moderately severe blood-loss, no abnormal physical signs were elicited. B.P. 140/90. Hb 52 per cent. Blood-urea 69 mg. per cent.

Gastroscopy (Dr. McAllen).—" The gastroscope passed easily. An enormous mass was seen, bulging into the stomach from the posterior stomach wall, covered with rugæ and somewhat irregular (*Fig.* 610). The instrument was passed beneath the mass, much of which had a smooth surface. No ulceration was seen."

Radiological Report (Dr. Abeles).—" A large constant filling defect is seen in the pars media of the stomach posteriorly, not involving the greater or lesser curvatures (*Fig.* 611). A crater is present in the middle of the mass,

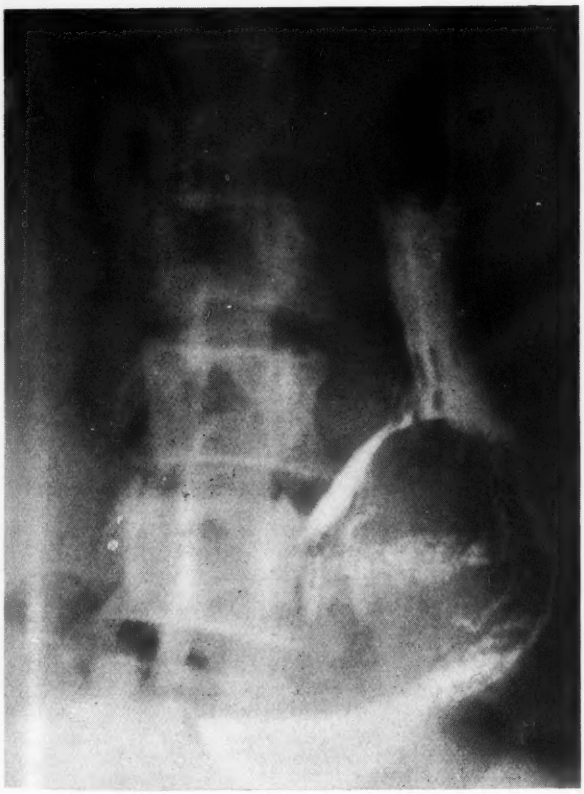

Fig. 611.—Barium meal showing large filling defect in pars media. The widely spaced rugæ are seen as faint vertical lines.

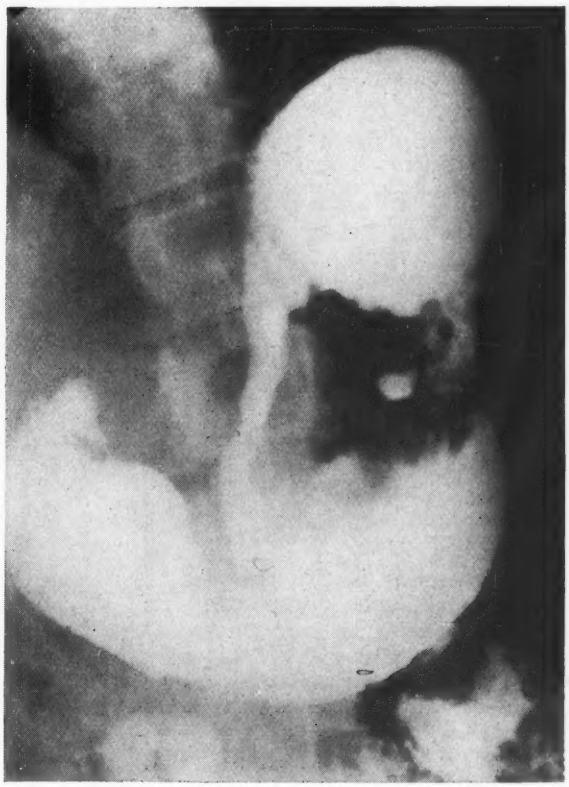

Fig. 612.—Barium meal showing filling defect and central ulcer niche.

suggestive of an ulcer (*Fig.* 612). The appearances are consistent with the diagnosis of a non-malignant tumour."

The patient was recommended for operation by Dr. Coghill, under whose care she was admitted, as a case of probable innocent neoplasm of the stomach.

AT OPERATION (L. A. I.).—Anæsthesia: regional and posterior splanchnic block (Dr. Byrne). The abdomen was opened through an upper midline incision and the stomach delivered. A mobile mass the size of a tangerine was felt arising from the posterior wall of the stomach.

FIG. 613.—The operation specimen.

A Polya-Hofmeister gastrectomy with a retrocolic anastomosis was performed, division of the stomach well clear of the growth being secured with the aid of a von Petz sewing clamp. Recovery was uneventful.

PATHOLOGICAL REPORT (Dr. Counsell).—" The resected specimen shows a tumour $3\frac{1}{4} \times 2\frac{1}{2} \times 1\frac{3}{4}$ in. elevation arising from the posterior stomach wall (*Fig.* 613). The growth is covered by mucosa containing several punched-out shallow ulcers.

" The tumour is composed of small whorls of plump, fusiform, epithelium-like cells with ovoid nuclei in a scanty fibrous stroma. Whilst the nuclei vary somewhat in depth of staining, they are fairly uniform in size and shape and no mitoses have been seen. The tumour is considered to be a neurofibroma of epithelioid type (*Fig.* 614)."

DISCUSSION

Hæmatemesis is the presenting symptom *par excellence* in simple gastric neoplasms, in contrast to malignant growths, in which frank loss of blood is rare. The vascular erosion leading to hæmorrhage is a sequel to superficial ulceration of the mucosa consequent upon underlying necrosis of the growth. Bleeding may be so profuse and persistent as to call for urgent gastrectomy (Temple, 1949). As in the present case, other symptoms are generally absent and appetite and digestion remain healthy over many years, rendering a diagnosis of peptic ulceration unlikely.

The X-ray appearances are those of a filling defect and in favourable circumstances the rugæ of the gastric mucosa are seen, widely separated, indicating that the mucosa is intact but stretched over the tumour. A central ulcer niche is a characteristic finding and is well shown on the accompanying radiograph (*Fig.* 612). Although a valuable confirmatory sign, it cannot be considered as indicative of any one particular type of tumour and may occur in any benign submucosal growth. Canney (1948) considers that the presence of several ulcers might suggest malignancy, but in the case under consideration three fair-sized ulcers were present, although only one was visualized on the radiograph.

Academic interest in the present case is focused on the histology of the tumour, which corresponds to the epithelioid type of neurinoma described by Willis (1948). The structure is that of a mass of closely aggregated, short, plump cells and scanty or absent intercellular fibres, and is easily confused with a leiomyoma. Willis comments that he has seen this histological formation in only two tumours, both from the stomach.

My thanks are due to Mr. W. J. Ferguson for allowing me to treat this case; to Miss Robinson and Mr. Vinten for the paintings and photography; and to Dr. Abeles and Dr. Counsell for much helpful assistance with the radiology and pathology.

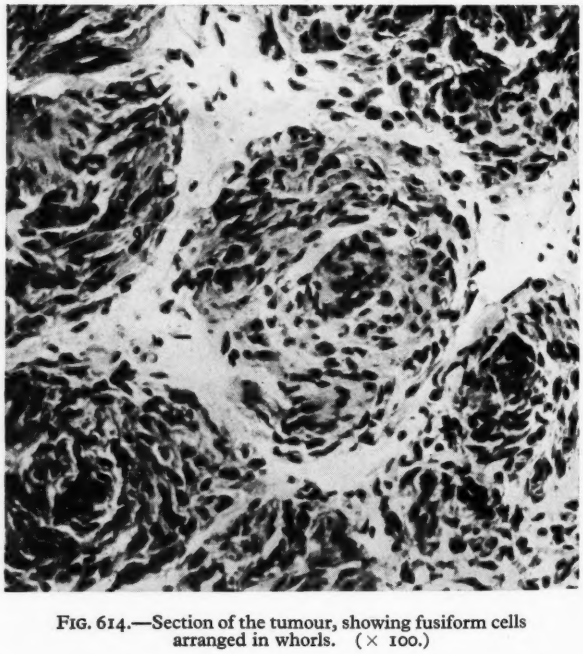

FIG. 614.—Section of the tumour, showing fusiform cells arranged in whorls. (× 100.)

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PERFORATION OF LEIOMYOSARCOMA OF STOMACH

By JOHN A. SHEPHERD, Liverpool

According to Ewing (1940) sarcomata comprise 1 per cent of all gastric tumours. In a study of Mayo Clinic records, Masson (quoted by Balfour and McCann, 1930) gives the proportion of one gastric sarcoma to 150 gastric carcinomata. Ewing divides gastric sarcomata histologically into three groups: spindle-cell sarcoma (myosarcoma); lymphosarcoma; and round-cell or alveolar sarcoma. Schlesinger gives a morphological division (Ewing, 1940): endogastric, exogastric, and diffuse or infiltrating tumours. An exogastric leiomyosarcomatous type of growth is described in this paper. Such leiomyomatous tumours have been studied by Golden and Stout (1941), who record eight benign to one malignant growth. Chaffin (1938) collected records of 363 leiomyomata of the stomach, of which 23 per cent were considered malignant. Since 1938 numerous additional individual cases of leiomyomata —benign and malignant—have been published, and it must be recalled that small, previously symptomless, leiomyomata are a fairly frequent finding at autopsy. The following case is recorded in view of the unusual and dramatic presentation of the tumour.

CASE REPORT

W. M. (R.I. 81969/48), a gardener aged 51, was admitted to the Radcliffe Infirmary on Jan. 12, 1948. For two weeks before admission he had had vague indigestion in the form of epigastric pain " fairly soon after meals ". He had a sudden onset of abdominal pain ten hours before admission, while completing his night's rest. This pain was continuous up to the time of admission, at first in the upper abdomen and then shifting to the right lower abdomen. His bowels had opened once since the onset of the pain and he had passed a normal stool. He had not vomited and there had been no disturbance of micturition. For the last three hours there had been pain in the right shoulder, but no other radiation.

On Examination.—He looked ill, pale, and in distress. His temperature was 101° F., pulse 110, and respiration 25. An immobile distended abdomen was seen. There was silence on auscultation in all quadrants and extreme rigidity combined with exquisite tenderness prevented further information being obtained by palpation. The rigidity and tenderness seemed most marked in the right iliac fossa. Percussion was so painful that it could only be done over the liver area, which was dull. On rectal examination there was tenderness on palpation of the rectovesical pouch. A diagnosis of perforated peptic ulcer was made and the confirmation of a plain film was not sought as movement caused the patient so much discomfort. Immediate operation was advised.

At Operation. — General anæsthesia — Pentothal, ethyl chloride, ether and oxygen (Dr. Bryce Smith).

With abdominal relaxation secured, it was at once obvious that there was a large central abdominal tumour. A right paramedian incision was made, and on opening the peritoneal cavity large amounts of brown bloody effusion escaped. A large tumour presented as a pear-shaped fleshy mass attached by a narrow stalk to the lesser curve of the stomach about 2 in. from the pylorus. The weight of the mass had rotated the lesser curve anteriorly to lie below the greater curve. On the fundus of the tumour was a crumbling crater of blood-clot and necrotic tissue. This was the source of the hæmorrhage and the tumour had exploded to scatter its necrotic centre widely throughout the peritoneal cavity. The adjacent stomach wall was not obviously infiltrated and no hepatic or other metastatic deposits were found. The tumour was thought to be a simple myoma which had undergone necrosis from ischæmia and possibly infection. It was excised with an ellipse of healthy stomach after ligation of several large vessels from stomach and lesser omentum. The longitudinal incision in the lesser curve was repaired in two layers without producing any gross deformity. The abdomen was closed with drainage of the peritoneal cavity.

Post-operative Course.—An intravenous transfusion was begun during the operation and one pint of blood and three pints of plasma were given. Gastric suction was employed for twenty-four hours after operation and then fluid and solid intake were increased orally.

He made a satisfactory and uneventful convalescence. When questioned further about his condition before the catastrophe he admitted to a longer period of indigestion than two weeks and that about ten days before admission he had been conscious of a lump in his abdomen.

He was discharged to a convalescent home eighteen days after operation and was re-examined at monthly intervals. Eighteen months later he was well and completely free from any gastric disturbance. No clinical evidence to date suggests recurrence of the condition.

Pathological Reports.—

1. *Swab from Necrotic Surface of Tumour.*—Few pus cells shown by Gram stain. Numerous Gram-positive organisms—cocci rods and coliforms. On culture, *B. coli* and *Str. fæcalis* grown.

2. *Report on Tumour.*—The tumour measured 17·5 × 15 × 9 cm., and its shape is seen in the illustrations (*Figs.* 615, 616). In the posterior view the dimple of a diverticulum or mucosal evagination is clearly apparent at the top of the picture. This diverticulum is seen in the sagittal section to continue as a channel right through the necrotic centre of the tumour to the artificial orifice, where the tumour had ' exploded ' into the peritoneal cavity through a gap in the anterior aspect of the fundus, 6 cm. broad and 4 cm. across.

The tumour is dark in colour and is seen to be highly vascular and to be wholly encased in a layer of peritoneum save where this has ruptured at the fundus: the peritoneal investment is mainly smooth, but there are many fibrous adhesions over it, and it has lost its characteristic sheen.

Microscopically, the evagination is lined with mucin-containing cells, for the most part columnar, and typical of the gastric mucosa nearby. There is much cellular infiltration in the mucosa with lymphocytes, plasma cells, and eosinophils, and there are occasional lymphoid aggregates in the deeper part. At the edge of the evagination and in its depths there is atrophy of the deeper parts of the gastric glands, and, deep inside the tumour, just before the mucosal lining of the fistula gives place to soft necrotic cellular material with many neutrophils and lymphocytes, the mucosa is also atrophied and its cells no longer contain mucin.

Arising, apparently, in the muscular coats of the stomach there is a tumour growth, the principal cell-type of which is a large spindle-shaped leiomyocyte with a well-defined lightly-stained nucleus containing a fine chromatin network. Mitotic figures are seen in these cells, but they are not numerous. There is variation in the appearance in different areas of the tumour, from very considerable cellularity to sparsely cellular areas with hyaline, granular, or vacuolated acidophil material, and there are a few incomplete fibrous septa. Lymphocytes and eosinophils, with a few neutrophils, are scattered

in varying numbers in every field. There are many thin-walled, widely dilated, vascular spaces, but their number is not excessive.

The whole tumour is encased in a serous coat, with several layers of stretched-out smooth muscle and fibrous-tissue strands underneath, from which the tumour-cells apparently take origin. There are many congested blood-vessels in this wall. The wall ends abruptly at the margins of the perforation. The appearances are those

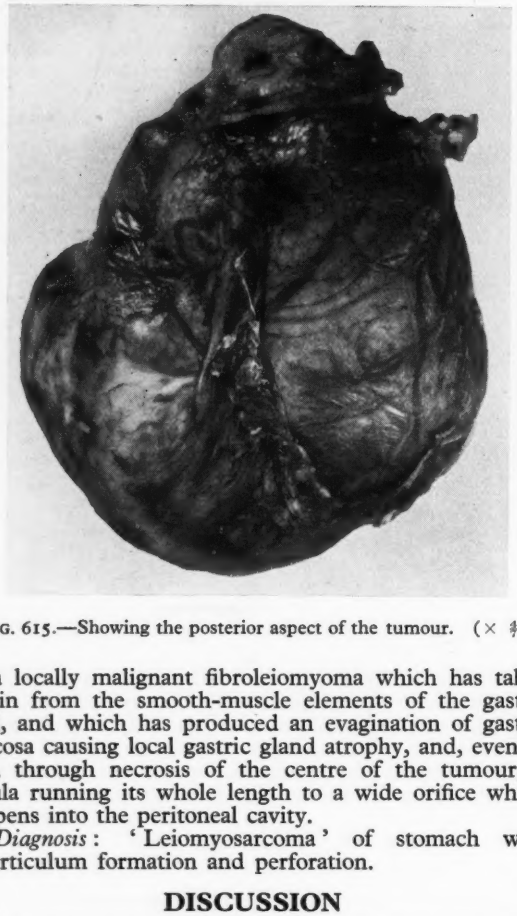

FIG. 615.—Showing the posterior aspect of the tumour. (× ⅓.)

of a locally malignant fibroleiomyoma which has taken origin from the smooth-muscle elements of the gastric wall, and which has produced an evagination of gastric mucosa causing local gastric gland atrophy, and, eventually, through necrosis of the centre of the tumour, a fistula running its whole length to a wide orifice where it opens into the peritoneal cavity.

Diagnosis: 'Leiomyosarcoma' of stomach with diverticulum formation and perforation.

DISCUSSION

The symptoms produced by gastric tumours other than carcinomata are notoriously misleading. Endogastric tumours may produce bleeding as they tend to ulcerate on the mucosal surface. Exogastric tumours present less obviously, as they seldom bleed or obstruct in the earlier phases. In a few cases the patient may notice a mass, as in the present case, although this was not at first elicited in the history. The vague and variable indigestion accompanying endogastric or exogastric tumours cannot be pathognomonic and may simulate either peptic ulcer or carcinoma. The general debility which is associated with very large tumours may well suggest a diagnosis of carcinoma. Radiology may be of assistance, but ulcerating lesions again may masquerade as carcinomata and exogastric ones may distort as would tumours of adjacent viscera. At least one calcified myosarcomatous tumour has been revealed (Allen and Herbert, 1939).

Few cases appear to have presented themselves as in this instance by some dramatic event. Hertzler (1936) refers briefly to a case of leiomyosarcoma which showed some of the features of the present example. He writes: "in one of my cases the blood-supply in the pendulous tumour became jeopardized and the irritation of the surface of the tumour caused an acute abdominal crisis. The rigidity of the abdominal muscles made the palpation of the tumour impossible". As disruption had not occurred, the tumour was resected intact.

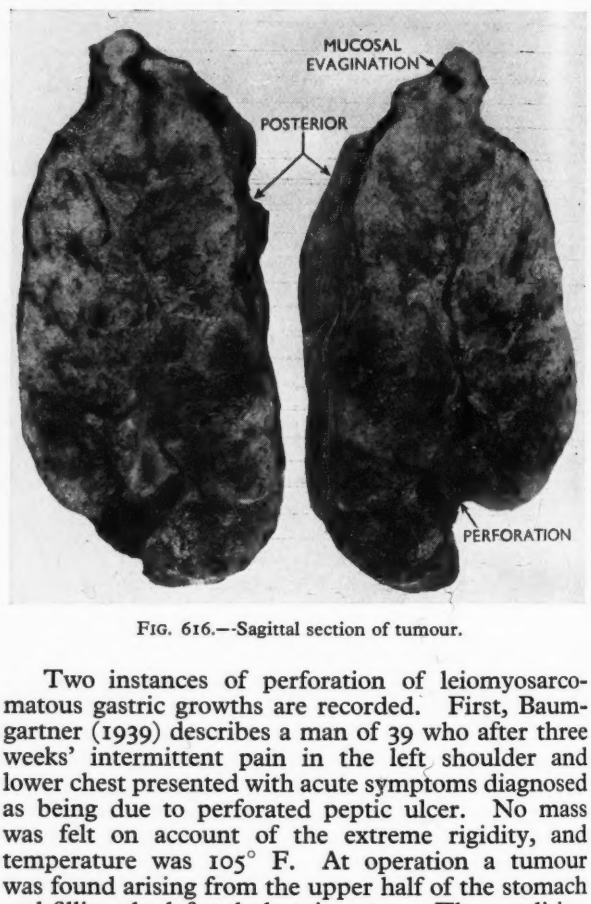

FIG. 616.—Sagittal section of tumour.

Two instances of perforation of leiomyosarcomatous gastric growths are recorded. First, Baumgartner (1939) describes a man of 39 who after three weeks' intermittent pain in the left shoulder and lower chest presented with acute symptoms diagnosed as being due to perforated peptic ulcer. No mass was felt on account of the extreme rigidity, and temperature was 105° F. At operation a tumour was found arising from the upper half of the stomach and filling the left subphrenic space. The condition was regarded as inoperable and the patient died three days after laparotomy. At post-mortem the mass was noted to be partly endogastric and partly exogastric. The serosal surface was covered with a seropurulent exudate and there were multiple perforations through the tumour from the lumen of the stomach. Histological diagnosis: leiomyosarcoma.

Secondly, Mass and Kirshbaum (1940) report a man of 41 who had vague lower chest pain and was later known to have an abdominal mass. Radiologically he was thought to have an ulcerating carcinoma and the condition was considered inoperable. Two days before death his tumour perforated, with symptoms similar to those described by Baumgartner. At post-mortem the growth was shown to be a leiomyosarcoma which had spread to the liver and perforated into the general peritoneal cavity because of necrosis.

These are therefore examples of advanced and inoperable growths producing acute clinical pictures just before death.

Perforation of lymphosarcomatous ulcers is discussed by Kouchy, Beck, and Atlas (1941), and although such cases are in a different category from those discussed in this paper, it is timely to suggest that biopsy in the course of operation for perforation of unusual ulcers of the stomach may reveal these cases.

No instance has been traced of rupture of a malignant leiomyoma of the stomach with survival as in this case, but Millar (1928) has recorded hæmorrhagic degeneration of a simple exogastric leiomyoma which also produced acute symptoms suggesting peptic ulcer perforation. At operation there was blood in the peritoneal cavity originating from the lesser sac, where there lay a pedunculated tumour. The tumour had not ruptured, but bleeding was presumed to arise from its surface. It was resected and proved to be a leiomyoma. The patient made a good recovery.

Degeneration of leiomyomatous tumours of the stomach according to Hertzler (1936) suggests malignant change, although ischæmia of large simple tumours may well be associated with infection in producing degeneration. Bosselation occurs in malignancy and fixation or metastatic deposits confirm this. Golden and Stout (1941) report 30 per cent of leiomyosarcomata of the stomach reviewed by them as showing metastases and prefer the term 'malignant leiomyoma'. It is obvious that each case must be judged on its clinical and histological merits and that extreme variations of malignancy occur as with muscle tumours elsewhere in the body.

Necrosis of large malignant tumours may be caused by various factors. The tumour may outgrow its blood-supply and ischæmia may produce necrosis. Hæmorrhage from thin-walled vessels may cause softening. Infection may occur, as undoubtedly happened in this case, from the lumen of the stomach through a mucosal ulcer or through a diverticulum, as observed in this case and in other pedunculated gastric tumours (Hertzler, 1936). Probably all these factors combined in the present case to produce the acute picture.

Treatment.—In the present case a limited excision was done and it is premature to say that this was sufficient. Lahey and Colcock (1940) have inferred that a radical gastrectomy is the operation of choice for these growths, but they discuss endogastric tumours only. Golden and Stout (1941) advise sleeve resections and less radical procedures. If the diagnosis of malignancy is made, it would seem best to do as radical a gastrectomy as the conditions will allow.

In retrospect three diagnostic points might have been taken in favour of a pre-operative diagnosis other than that of a perforated peptic ulcer. First, the history of a pre-existing mass might have been elicited by more careful questioning; secondly, a temperature of 101° F. should have been considered unlikely after a perforation of some ten hours' duration—this temperature was probably associated with the hæmoperitoneum but may have been due to infection; thirdly, a plain X-ray film of the abdomen might have revealed the tumour mass.

SUMMARY

A case is described where a pedunculated leiomyosarcoma of the stomach ruptured to simulate a perforated peptic ulcer. Operative removal of the tumour was followed by recovery.

I am indebted to Mr. D. Abernethy for permission to record this case, Dr. A. Robb-Smith for advice and criticism, and Dr. G. A. C. Summers for the description of the tumour and for the illustrations.

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A CANCELLOUS OSTEOMA IN THE BREAST

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THE literature records very few examples of bone-containing breast tumours and the unusual case described below was considered of sufficient interest to be placed on record.

CASE REPORT

CLINICAL HISTORY.—The patient was a married woman, aged 65, who had noticed a lump the size of an almond in the right breast for three months prior to operation. The lump had been increasing in size.

ON EXAMINATION.—There was a stony-hard tumour the size of a walnut situated in the inner and upper quadrant of the right breast. There was slight skin fixation of the mass, but no enlarged glands could be felt in the axilla.

AT OPERATION.—A right radical mastectomy was done and a number of soft glands embedded in the axillary fat removed.

PATHOLOGICAL REPORT.—The specimen consisted of an amputated breast with overlying nipple, areola, and axillary contents. Underlying the nipple and adjacent

breast there was an extensive area of fibrous tissue which macroscopically appeared to be an area of simple chronic mastitis without any evidence of growth. On the deep surface of the fibrous plaque to the inner side of the nipple there was a smooth-walled cystic space occupied by a nodular calcified mass 3·0 cm. in diameter. The calcified mass was readily removed from the space in which it was enclosed and did not appear to be attached to the cyst wall. On its deep surface it was separated from the pectoral muscles by a layer of fascia. The cut surface showed cancellous bony tissue surrounded by a smooth translucent layer of fibrous tissue or fibro-cartilage.

Microscopical Appearances.—Section taken from the fibrous mass in the breast showed changes of chronic mastitis with considerable hyaline fibrous stromal overgrowth (*Fig.* 617), and examination of the decalcified bone mass showed it to be a cancellous osteoma with numerous sinusoidal blood-vessels between the bone trabeculæ (*Fig.* 618). There were a few scattered collections of hæmopoietic cells which included an occasional normoblast, and a very large number of osteoblasts actively engaged in new-bone formation throughout the section. Newly-formed bone trabeculæ extended to the edge of the tumour and merged into the surrounding fibro-fatty breast tissue. The two axillary glands sectioned showed slight chronic lymphadenitis, but contained no secondary growth.

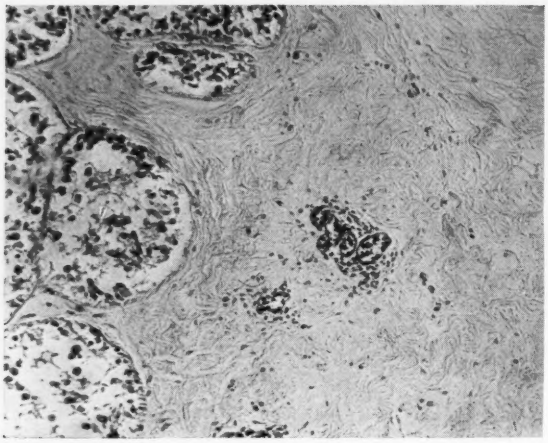

FIG. 617.—Section of breast tissue adjacent to the osteoma, showing changes of chronic mastitis with hyaline fibrous tissue overgrowth. (× 80.)

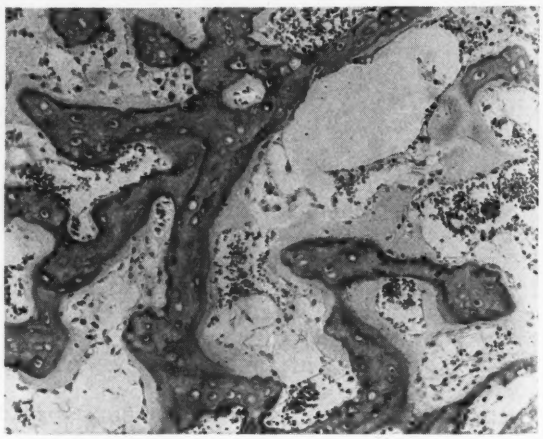

FIG. 618.—Section of the bony tumour mass, showing trabeculæ of cancellous bone surrounded with osteoid tissue. In the interstices there are numerous sinusoidal blood-spaces. (× 80.)

COMMENT

Bone- and cartilage-forming neoplasms form a small and rare group of breast tumours. Bonet (1700) was probably the first person to describe in detail a calcified tumour mass in a female breast. Since then a few isolated cases of cartilage and bone-containing tumours have been reported. Rottino and Willson (1945) collected and reviewed most of the reported cases of these tumours, but included no example of a pure osteoma.

Chondromatous and ossifying tumours are more commonly found in the lower mammalia and it is probable that all tumours of this type have a close aetiological relationship. Most of the reported cases had been noticed by the patient for many years and only the rapid growth of the mass in the breast caused them to seek advice. Usually the tumours have remained circumscribed and freely movable within the breast, but in a few cases enlargement caused pressure necrosis of the overlying skin with the production of a fungating mass.

In many cases osseous and cartilaginous metaplasia has occurred in conjunction with a pre-existent breast tumour, usually a fibro-adenoma, and some have become undoubted cases of osteogenic sarcoma (Sutton, 1910) and osteochondrosarcoma with the production of distant metastases. In the case recorded above the tumour appeared to be a simple cancellous osteoma containing a small amount of heterotopic bone-marrow. It probably arose by a process of metaplasia in the hyaline fibrous stroma of a breast in which chronic mastitis was present.

SUMMARY

A case of a cancellous osteoma of the breast is reported and its origin by a process of metaplasia from the condition of chronic mastitis described.

Our thanks are due to Dr. J. B. Bamforth for the use of his specimens.

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SIMPLE DEPRESSED FRACTURE OF THE SKULL ASSOCIATED WITH PAGET'S DISEASE

By A. G. McPHERSON

CASE REPORT

H. B., a male railway worker, aged 68, was admitted to The Royal Infirmary, Sheffield, on March 16, 1949, having fallen while at work at the side of the railway and struck his head on the line.

FIG. 619.—Radiograph showing the depressed fracture and also changes characteristic of Paget's disease.

On admission he was conscious, rational, and co-operative, and demonstrated no abnormal physical signs in the central nervous system. He had been unconscious for a short period after the accident and had an amnesia for about four hours, including a brief period of retrograde amnesia. A few superficial abrasions were present over the occipital region of the scalp, and underlying this area a distinct depression of the skull could be felt.

X-ray examination confirmed the presence of a depressed fracture of the skull and disclosed the changes of Paget's disease (*Fig.* 619). Paget's disease was also demonstrated radiologically in other parts of the skeleton, being most marked in the pelvis.

In view of his age and lack of central nervous disturbance, the patient was treated conservatively, and apart from fairly severe localized headache over the fracture, which persisted for about two weeks, he showed no ill effects.

DISCUSSION

Simple depressed fracture of the skull in the adult is an infrequent occurrence, and in this case may be regarded as a pathological fracture. Involvement of the skull by Paget's disease is frequent and pathological fracture is a common complication of the disease, nevertheless pathological fracture of the skull in Paget's disease must be very rare. Thus Dickson, Camp, and Ghormley (1945), reporting a series of 337 cases of osteitis deformans, found 77 fractures, none of these involving the skull, though the skull was affected by the disease in 153 of these patients.

I am indebted to Professor R. St. Leger Brockman for permission to publish this case.

REFERENCE

DICKSON, D. B., CAMP, J. D., and GHORMLEY, R. K. (1945), *Radiology*, **44**, 449.

TRAUMATIC RETROPERITONEAL RUPTURE OF THE DUODENUM

By J. A. SIMPSON

TRAUMATIC retroperitoneal rupture of the duodenum by blunt force applied to the abdomen is a rare injury. Johnson (1944), in a review of the literature from 1910 to 1943, reports on 52 cases.

The trauma is often trivial and the onset of serious symptoms slow. Consequently the diagnosis is not infrequently missed, and even at laparotomy the lesion may not be recognized unless it is kept in mind and specifically sought. As a result the mortality is high—50 per cent in Johnson's series.

CASE REPORT

J. E., a healthy girl of 15, was admitted at 9.30 p.m. on July 11, 1947. At 3.30 p.m. that day, while running across a railway, she tripped. She fell heavily on her abdomen across the line, bumped her chin on the ground, and bit her tongue. She was able to pick herself up and walk about a quarter of a mile home. She vomited twice. The first vomitus contained some blood, which her family doctor thought had come from her tongue and had been swallowed. She was sent to hospital for observation.

On admission she was complaining of fairly severe generalized abdominal pain, and a pain in the left shoulder, which had commenced about two hours after the injury.

ON EXAMINATION.—She was lying quietly. Her face was pale and her skin clammy. Temperature 99.2°; pulse 120; blood-pressure 118/76 mm. Hg. The respiratory rate was 20 per minute and there was a catch at the end of inspiration.

There were small lacerations of the chin and tongue. The abdomen showed generalized tenderness and increased muscular resistance, most marked in the epigastrium. Rebound tenderness was present. No bowel sounds were heard. The abdomen was tympanitic on percussion, with no abnormal dullness in the flanks.

Rectal examination revealed tenderness in the pouch of Douglas.

A provisional diagnosis of ruptured spleen was made. She was prepared for operation and eight hours after injury she was taken to the theatre.

AT OPERATION.—The anæsthetic was gas–oxygen, ether, and curare.

The abdomen was opened by a long upper left paramedian incision. There was a small quantity of blood in the peritoneal cavity, but the spleen was quite normal.

Exploration revealed a large retroperitoneal hæmatoma lying over the head of the pancreas, and extending into

the base of the transverse mesocolon. A small quantity of thick bile-stained mucus was found in this region, and there were a few plaques of fat necrosis.

On palpating the duodenum a rent $2\frac{1}{2} \times \frac{3}{4}$ in. was found on the posterior wall involving the distal inch of the first part and the commencement of the second part. An attempt was made to visualize the lesion by mobilizing the duodenum, but a satisfactory exposure could not be obtained. The stomach was therefore divided through the pyloric antrum and the duodenum turned back; the tear was then fully seen. Its edges were bruised and lacerated. There was also a small wound about $1\frac{1}{2}$ in. long in the head of the pancreas. There was no evidence of injury to the common bile-duct.

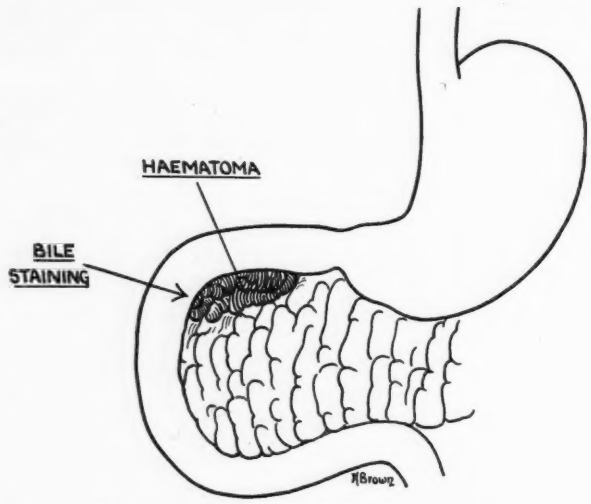

FIG. 620.—Showing the findings at operation.

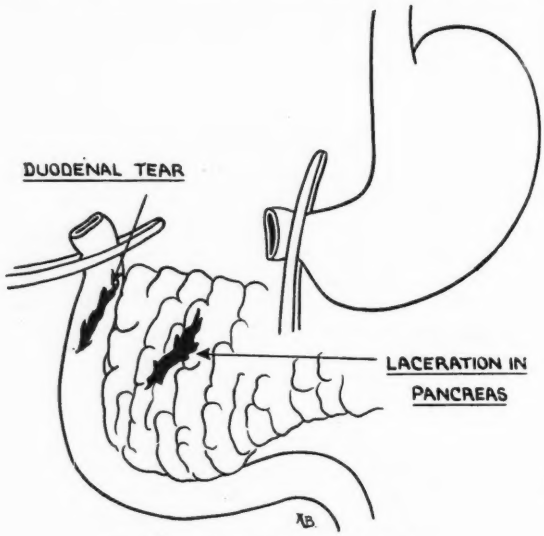

FIG. 621.—The exposure of the lesion.

The duodenal tear was closed with two layers of linen thread sutures, and a few catgut stitches were inserted to repair the pancreatic wound. The proximal end of the duodenum was closed, and invaginated with a purse-string suture. The distal cut end of the stomach was brought down through the mesocolon and an end-to-side anastomosis made between it and the proximal jejunal loop.

The wound was closed in layers, with a tube-drain passing to the region of the duodenal stump through a separate stab incision.

PROGRESS.—Following the operation the patient received 2 pints of blood. Continuous gastric suction was set up and maintained for 48 hours. The intravenous drip was continued during this time. Thereafter she received a light diet which was speedily increased to normal.

On the third post-operative day a small quantity of bile-stained fluid drained through the tube, but dried up after two days. The drain was removed on the sixth day and she was allowed out of bed.

The stitches were removed on the sixteenth day. She went home on the nineteenth day with her wound soundly healed.

She reported six weeks after the operation, looking and feeling very well. A barium-meal examination showed a satisfactory functioning anastomosis.

A follow-up report on Jan. 12, 1949, eighteen months after the injury, confirmed that she has remained well.

DISCUSSION

Aetiology.—Closed rupture of a hollow viscus is thought to be due to either a crush or a 'burst' injury. There may be a 'blow out' of the gas in the stomach when that organ is suddenly compressed, or the duodenum itself may be crushed against the vertebral column. Several authors (Johnson, 1944; Salisbury, 1945) report cases of 'burst' injury. In this case the considerable laceration of the wound edges and the damage to the head of the pancreas suggest rather a crush type of injury. There was, however, no external bruising, and no bruising was found in the muscle layers of the abdominal wall.

Diagnosis.—The history of trauma is frequently slight and the patient may walk from the scene of the accident. As there is spread of the retroperitoneal effusion or generalized peritoneal spread so the pain increases. Vomiting is a usual feature. The clinical picture at first appears considerably less acute than in an intraperitoneal rupture, unless there is an associated hæmoperitoneum or other injury.

At operation the lesion should be remembered when bile staining of the retroperitoneal tissues is found, or even, as Laritzen (1947–8) points out, when there is retroperitoneal hæmorrhage or œdema in the upper right quadrant of the abdomen.

Treatment.—Early operation is the treatment of choice. Cases of what has apparently been retroperitoneal duodenal rupture have recovered spontaneously. Sperling and Rigler (1937) reported a case where the diagnosis was made by X rays and conservative treatment by gastric suction and rectal saline was successful.

Most cases not subjected to operation, however, die within 48 hours from peritonitis or retroperitoneal cellulitis.

The operative treatment depends on the findings at laparotomy. Poindexter (1935) advises that the least possible operation should be done at first. The immediate aim is to save life. If necessary, secondary operations, such as gastro-enterostomy, can be done later.

Johnson (1944) advises mobilizing the duodenum by dividing the peritoneum on its lateral aspect.

Simple closure, where possible, would seem to be the obvious line of treatment. In this case, however, the laceration was inaccessible and the

manœuvre described by Fraser (1942) was adopted. The rent was thereby easily closed.

All authors are agreed on the advisability of drainage to the site of injury as some leakage is usual. A separate stab incision will allow primary healing of the laparotomy wound.

Post-operative treatment follows the usual lines with gastric suction, intravenous fluids, and chemotherapy where necessary.

The common post-operative complications are fistula, retroperitoneal cellulitis, peritonitis, subphrenic abscess, and duodenal stenosis.

SUMMARY

A case of traumatic retroperitoneal rupture of the duodenum with recovery is reported. This is a rare injury with a bad prognosis.

The diagnosis is difficult and may be missed at operation.

Retroperitoneal œdema with bile or blood staining suggests duodenal injury.

Early operation with simple closure of the rupture is the treatment of choice; but the operative procedure depends on the findings at laparotomy.

Division of the pyloric antrum was necessary to display and repair the rent.

My thanks are due to Mr. R. M. Hill for permission to publish this case, and to Miss A. L. Brown for the diagrams.

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REVIEWS AND NOTICES OF BOOKS

The Principles and Practice of Rectal Surgery. By WILLIAM B. GABRIEL, M.S. Lond., F.R.C.S. (Eng.), Surgeon to St. Mark's Hospital for Cancer, Fistula, and other Diseases of the Rectum; Surgeon to the Royal Northern Hospital. Fourth edition. 9⅝ × 6 in. Pp. 508 + x, with 11 coloured plates and 278 text illustrations, some coloured. 1948. London: H. K. Lewis & Co. Ltd. 45s. net.

THE great value of this book to every practising surgeon is shown by the fact that this is the fourth edition since it was first published in 1932.

It is an epitome of the practice and operative methods used at St. Mark's Hospital except for the fact that there is no mention of the synchronous combined method of operating by the abdomino-perineal method for carcinoma of the rectum. The author prefers the perineo-abdominal operation in one stage to any other. His personal experience is now (1948) over 660 cases. He maintains "that if a proper period is devoted to preparation of the patient a two-stage combined excision has no advantage over a one-stage operation . . . the operation can be recommended with confidence, not only in the good risk, but also in that fairly large class of patients who, on account of age or poor physique, would usually be considered unsuitable for a combined excision of the rectum".

The operation itself is described in minute detail, but even more so is the pre- and post-operative treatment and the possible complications. The patient must be made safe for surgery. This is the text really of the whole book, in discussing all the surgical procedures which may be necessary for the relief of rectal disease. There is no such thing as minor surgery. This has been a fashionable expression for many years, being used to describe certain surgical procedures. Schedules of minor and major procedures have been drawn up, with no reference to the skill required to carry them out. The fact, however, remains that though they are considered by some to be minor procedures the after-effects of operations for hæmorrhoids, phimosis, or 'ruptured perineum' may make the patient's subsequent life utterly miserable.

Throughout the book the author acknowledges the help and encouragement he has received from his colleagues in the anatomy of the rectum, and in many of the operations, and above all in pathology from Dr. Cuthbert Dukes.

The whole surgical profession will echo these thanks. The grading of cancer of the rectum introduced many years ago by Dr. Cuthbert Dukes has now been adopted over the whole world.

The whole book reflects the sterling honesty of the author and his colleagues in presenting the results and the methods they have found the best. Other methods are described and criticized in a friendly and just manner.

It is impossible to review a standard book such as this. It should be purchased and studied by all surgeons, and even those who will never do a rectal operation should read it in order to visualize how they will endeavour to present their facts and theories when they decide to write the standard text-book on their own specialty.

Cystoscopy and Urography. By J. B. MACALPINE, D.Sc., F.R.C.S., lately Honorary Surgeon and Surgeon-in-Charge of the Genito-urinary Department, Salford Royal Hospital; Consulting Urologist, Christie Hospital and Holt Radium Institute, Manchester; etc. Third edition. 9 × 6 in. Pp. 554 + 16, with 338 illustrations in the text and 15 coloured plates. 1949. Bristol: John Wright & Sons Ltd. 63s.

To those who appreciate the value of a classic, copies of the second edition of this book have for some years been more precious than gold; owing to the ravages of war new copies were unobtainable, and even a reprint of that edition would have been welcome. Mr. Macalpine has, however, gone one better; he has given us a third edition with new matter and illustrations, bringing the book up to date without destroying any of its previous good qualities.

The original first edition was entitled *Cystoscopy*, but there has been a considerable expansion of its scope in the present volume. This was inevitable in dealing with a subject which is advancing so rapidly as urology; the addition of urographic methods made a revision of the title necessary in the second edition, and the third contains accounts of those aspects of urology which can be based on cystoscopic or radiographic observations and pathological principles.

The new chapter on the pathology of renal tuberculosis is a fine example of the thoughtful care which the

author has devoted to his subject; the controversial problems regarding the mode of infection and spread of the disease are discussed in a systematic way, and the evidence for each theory is thoroughly sifted. The conclusion that renal tuberculosis can and often does heal is in line with modern concepts.

In so comprehensive a work by one author there must always be some differences of opinion on detail; the section on endoscopic resection of the prostate describes it as a method of partial prostatectomy, and the results of such a technique have been found wanting both here and elsewhere. The excellent results obtained in some clinics are undoubtedly due to a full resection amounting to a subtotal removal of the gland. Some new matter has been introduced in the section on Bladder Tumours, and some of the beautiful illustrations taken from the author's articles in the BRITISH JOURNAL OF SURGERY on papillary tumours of the renal pelvis are also included.

Mr. Macalpine has recently become the first recipient of St. Peter's Medal of the British Association of Urological Surgeons for his outstanding contributions to urology. One justification for that award, if such were needed, is in this book. It is an outstanding example of all that is best in British surgery both in conception and production, and the author and publishers deserve the thanks and congratulations of urologists throughout the world.

An Atlas of Traumatic Surgery. Illustrated Histories of Wounds of the Extremities. By JOSEP TRUETA, M.D. (Barcelona), D.Sc. (Hon.) Oxon, F.R.C.S. (Hon.) Canada, Surgeon at the Wingfield-Morris Orthopædic Hospital, Oxford. $7\frac{1}{4} \times 9\frac{3}{4}$ in. Pp. 150 + viii, with 188 illustrations. 1949. Oxford: Blackwell Scientific Publications. 30s.

IN a short introduction the author restates the principles of his treatment of war wounds, and re-affirms his belief in them. He then gives clinical data of 40 cases of compound fracture of the limbs, the majority selected from a series of 127 serious casualties admitted to the Wingfield-Morris Orthopædic Hospital after D-day. They are all illustrated by excellent photographs and the course of each case is followed to the final result.

As a proof of the efficacy of the treatment the book is convincing; as a record to be preserved for all time of the methods successfully used in World War II it is superb.

Radon: Its Technique and Use. By W. A. JENNINGS, B.Sc., A.Inst.P., Physicist to the Royal Northern Hospital and Prince of Wales's General Hospital Joint Radiotherapy Centre; and S. RUSS, C.B.E., D.Sc., F.Inst.P., Formerly Physicist to the Middlesex Hospital, London. $8\frac{3}{4} \times 5\frac{7}{8}$ in. Pp. 222 + x, with 14 plates and 49 illustrations in the text. 1948. London: John Murray, for the Middlesex Hospital Press. 18s. net.

THE names of the authors justify the claim made in the preface that this book has been "written as a book of reference on the subject of radon".

In the Foreword Sir Edward Mellanby states that as long ago as 1924 the M.R.C. asked Professor Russ to organize a service at the Middlesex Hospital for the supply of radon, as there was no doubt that it could be used with great advantage in the treatment of cancer.

It was realized that the technique for the production of radon is very exacting "and elaborate measures have to be taken in the interests of accuracy, safety of personnel, and the development of new forms of technique".

Considering the work done by Professor Russ and his staff in developing the science of radiotherapy, no better choice could have been made by the M.R.C.

It was in 1899 that Debierne described the emanations emitted by the rare substance actinium which he had discovered. In 1900 the late Lord Rutherford described the emanations emitted by thorium, and soon after Dorn discovered that radium gave off a radio-active emanation and this radio-active gas was named radon. It is formed spontaneously from radium and its production cannot be accelerated by any known means.

It is extremely dangerous for those technicians taking part in its storage, and it is not advisable that they should do this work for more than two years.

As is well known, the chief demand for radium is in the field of medicine; this consumes about 85 per cent of the world supply, the remainder being absorbed by industry either in the production of luminous dials or the detection of flaws in metals.

Professor Joly, of Dublin, was the first to recommend the use of radon in medicine in about 1914. He organized a plant, under the auspices of the Royal Dublin Society, for storing the radon in sealed capillary tubes encased in a platinum container so that it could be placed in the tissues and left in situ indefinitely. Other centres for its production were inaugurated and ultimately there were nine in the United Kingdom.

The advantage of radon seeds in radiotherapy is that they have practically no monetary value, so they can be used for ambulatory patients living at their own homes. They can be used in places where it is difficult to insert radium needles owing to their inflexibility, such as the palate and bladder, and they can be placed in septic lesions smeared with penicillin preparations or the sulphonamides.

The dosage can also be more accurately spaced in a radon tube than in a radium needle.

They were particularly useful during the war when there was a great fear that radium might be disseminated as the result of enemy action, and because of the relatively small amount of radium which was available.

Since the war radon has perhaps been much less used than other forms of radiotherapy. It is, however, well to remember that in certain tissues under some conditions it has a very great use and real value in the treatment of malignancy.

The book is essentially one for reference by the physicist attached to every radiotherapy centre. The physicist is as important in this work and method of treatment as the radiotherapist. It matters little who does the surgery of access so long as the dose and method of treatment is carefully controlled and accurately recorded. It is the first treatment which is the all-important one and should be the result of consultation between surgeon, radiotherapist, and physicist. In that way the safety of the patient is best protected and assured should any subsequent treatment by whatever means be necessary.

This book must surely be in the departmental library of every radiotherapy centre in the country.

Maladies du Squelette. By LUCIEN LEGER, R. DUCROQUET, and HENRY LEGER. $6\frac{5}{8} \times 9\frac{7}{8}$ in. Pp. 256, with 129 illustrations. 1949. Paris: Masson et Cie. 1200 fr.

THIS remarkable book is one of a series of monographs, chiefly on subjects of orthopædic interest, which have been written by a group of collaborators among whom Lucien Leger's name appears most frequently. The present volume is a study of eight rare diseases of bone, and its special value lies in the fact that the authors write from personal experience, giving clinical details and illustrating their records by a large number of radiographs, as well as providing numerous references to the literature of the subject. It is clear that they must have had access to a large amount of specialized

clinical material, and for this they acknowledge their indebtedness to Professor Mondor.

The conditions described are Albright's syndrome, xanthomatosis, and eosinophilic granuloma of bone, the bony manifestations of neurofibromatosis, melorrheostosis, Milkman's disease, essential osteoporosis, and myelomatosis. In regard to some of these, especially Milkman's disease, they state frankly that they are doubtful if the abnormality deserves the dignity of a clinico-pathological entity, and whether it may not be in fact the expression of some generalized metabolic upset. The book is the outcome of much careful research, and should be available to all who take a special interest in the pathology of bone.

Ulcers and Eczema of the Leg, Sequels of Phlebitis, etc. Studies on the Static Diseases of the Lower Limbs and Their Treatment. By HOLGER BISGAARD. With a Preface by Professor H. HAXTHAUSEN. 6⅜ × 9¼ in. Pp. 112, with 36 illustrations. 1949. Copenhagen: Einar Munksgaard. Dan. kr. 15.

THIS book is an extract of the Danish edition which was published in 1939. Dr. Bisgaard, who died in 1943, was a general practitioner who was very interested in patients suffering from varicose veins and their complications, viz., eczema, ulcer, or œdema in the ankle region. He thought these conditions could always be relieved by his treatment.

Before his death he asked his wife to arrange that his method of treatment should be published in countries other than Denmark and Scandinavia. Hence this present edition, with the Foreword by Professor Haxthausen, who testifies to the excellent results obtained after Dr. Bisgaard's methods had been adopted on a large scale in the State Hospital.

The treatment first consists of getting rid, by massage, of any infiltration (œdema) in the calcaneo-malleolar region (the 'coulisse') which is thought to account for the pain. The direction of the massage is from the plantar aspect of the foot over the coulisse to the lower part of the leg. The foot and leg is then encased in a Meisen bandage, pads of wadding being placed over the vulnerable points in the skin to prevent undue pressure. The Meissen bandage is not elastic in a transverse direction, but can be stretched longitudinally 200–300 per cent. The length of the bandage is from 3½ to 5 metres and the breadth 7 cm. The patient is kept mobile the whole time.

There is no mention of any operative treatment or the use of sclerosants in the book.

The illustrations and case reports do testify to Dr. Bisgaard's meticulous care of these patients, who, by many, are regarded as having little discomfort and making the most of their disability.

Anévrysmes artériels et Fistules artério-veineuses. Physiologie pathologique et Traitement. By RENÉ LERICHE, Professeur au Collège de France. 6½ × 9½ in. Pp. 312, with 50 illustrations. 1949. Paris: Masson et Cie. 900 fr.

THIS is the fifth volume in the series which Professor Leriche is compiling upon the subject of the pathology and surgery of the blood-vessels. Like its predecessors, this book records the experience of the author but also contains numerous references to the vast literature dealing with aneurysms and arteriovenous fistulæ—in fact one of the principal objects of the book has been to review former writing on these subjects, to try to sift out the wheat from the chaff, and to lay down principles of treatment which are founded upon sound scientific theory as well as upon experience. Leriche always alludes to relevant experimental research, and enjoys speculating upon the problems which are still unsolved—he mentions the fashioning of an arteriovenous fistula to promote the growth of a limb in a young animal, and the possibility of using the same method for the alleviation of arterial hypertension—but often leaves the reader to make up his own mind upon the reasonableness of his arguments or the feasibility of his suggestions.

He sets out afresh the morbid anatomy of arteriovenous fistulæ and lays special stress upon the great hypertrophy of the artery proximal to a fistula, a phenomenon which he is inclined to attribute to a vasomotor reflex rather than to any mechanical effects of the fistula. For the cure of fistulæ he recommends any form of suture which preserves the main arterial stream, whether the involved vein has to be sacrificed or not. As so often happens, and as evidently happened often to the author himself in the cases he has recorded here, it is difficult to find exactly where the fistula is, large abnormal vessels are encountered in unexpected situations, and in order to arrest hæmorrhage the well-laid plans for conservation of vessels have to be abandoned, and quadruple ligation has to be done to save the situation—often with most gratifying results!

Preservation of the arterial stream by some form of restorative aneurysmorrhapy, or even perhaps in future by grafting, is recommended for aneurysms, and it is pointed out that if conservative treatment is successful, sympathectomy to encourage a collateral circulation is not required, though it is advocated if the vessel has to be sacrificed. Judging by the cases quoted in this book, conservatism, though ideal, is not often practicable, though with the advent of heparin it is probable that reconstructive operations may become more frequently applicable. Obliterative aneurysmorrhaphy remains the operation of choice for a ruptured aneurysm, and when coupled with sympathectomy to aid the collateral circulation will usually succeed in saving the limb.

Fractures and Dislocations for Practitioners. By EDWIN O. GECKELER, M.D., Professor of Orthopædic Surgery, and Chief of the Fracture Service, Hahnemann Medical College and Hospital, Philadelphia. Fourth edition. 6 × 9 in. Pp. 371 + xii, with 344 illustrations. 1948. London: Baillière, Tindall & Cox. 27s. 6d.

Plaster of Paris Technic. By EDWIN O. GECKELER, M.D., Professor of Orthopædic Surgery, and Chief of the Fracture Service, Hahnemann Medical College and Hospital, Philadelphia. Second edition. 6 × 9 in. Pp. 220 + xiv, with 236 illustrations. 1948. London: Baillière, Tindall & Cox. 16s. 6d.

THESE two books, by the same author, may conveniently be considered together; the first has reached its fourth edition, and the other its second. Both are easy to read and are well illustrated. They are suited to the needs of registrars and house surgeons rather than more experienced workers, and the book on plaster-of-Paris technique is also to be commended to sisters in charge of plaster rooms. Unfortunately *Fractures and Dislocations* still contains errors which may mislead the novice. It is remarkable to find the statement that "ischæmic contracture is believed to be due to acute venous obstruction caused by the pressure of a large blood-clot"; ischæmic contracture is almost invariably due to arterial obstruction caused by spasm. Ice-tong callipers as a form of traction apparatus should have been discarded long ago. Most surgeons will disagree with the advice given for the treatment of comminuted fractures of the head of the radius; if less than one-third of the head is broken it is *not* the practice of most surgeons always to leave the remainder. Exception will also be taken to the author's method for the internal fixation of basal fractures of the neck of the femur; in this country and, we believe, in the United States, a Smith-Petersen nail attached to some form of plate is the appliance of choice,

rather than two long screws which must, of necessity, be insecure. The author's condemnation of open reduction for some fractures of the forearm bones is as surprising as his advocacy of excision for ununited fractures of the transverse processes of lumbar vertebræ. The caption for Fig. 68 is incorrect—the traction is applied through the heel, not through the knee; and the diagram in Fig. 234 shows an excessive amount of aponeurosis attached to each fragment of the fractured patella. The description of the method of application of a Tobruk plaster is inadequate, which is particularly unfortunate in view of the good uses that have been found for this type of fixation in peace-time surgical practice.

Nevertheless, these are useful books and they provide a fairly satisfactory approach to the surgery of bone and joint injuries.

An Introduction to Clinical Surgery. By CHARLES F. M. SAINT, C.B.E., M.D., M.S., F.R.C.S. (Eng.), Hon. F.R.A.C.S., Hon. F.G.S.S., formerly Professor of Surgery, University of Cape Town. Second edition. 9¾ × 6 in. Pp. 384 + viii, with 373 illustrations. 1949. London: H. K. Lewis & Co. Ltd. 45s. net.

THE second edition of this book contains a large number of clinical and pathological photographs which add to the usefulness of the volume.

It is pleasing in these modern times to read a book which sets forth the importance of surgical note-taking and reasoned thinking against the tendency to learn by 'parrot' fashion and the innumerable aids to diagnosis.

Medical students of to-day require such a book as this to make them clear-thinking practical clinicians.

The illustrations in this book are numerous and universally good.

This new edition incorporates the mellowed clinical acumen of a great teacher of surgery and is a reasoned explanation of surgical note-taking.

Clinical Radiation Therapy. By IRA I. KAPLAN, M.D., F.A.C.R., Clinical Professor of Radiology, New York University. Second edition. 6⅛ × 9¼ in. Pp. 844 + xvi, with 393 illustrations. 1949. New York: Paul B. Hoeber Inc. $15.00.

IT has been cynically said that when a new therapeutic agent has been discovered, it at first cures everything, then it cures nothing, and it is only after some years that its real therapeutic value can be assessed.

Such has been the case with radiotherapy, but it differs from most other forms of therapy in that it may do a great deal of harm. So much so that the so-called cure may cause more pain than the disease, and far from delaying the fatal termination it may even hasten it. The author naturally in the first chapter gives the history of the discovery of X rays by Röntgen in 1895 and of radium by Marie Curie in 1898. She and her husband obtained it, by permission of the Austrian Government, from the pitchblende waste at the Joachimsthal silver mines in Bohemia. The silver had been used for the prosecution of the Thirty Years' War, the coin minted being the thaler (dollar). It will be a nice argument in the future as to which has done most for the happiness of mankind, the dollar or radium. It may be that again "the stone which the builder rejected . . .". That is as may be; the fact remains that radio-active substances have a profound effect on the tissues of the body. The emanations can be obtained from salts of the metal, or artificially synthesized by electrical apparatus; and the modern tendency is to make more and more powerful apparatus producing voltages of one or two million volts.

The author then proceeds to explain the physics of radiation and the principles governing radiation therapy. It is this aspect that is so confusing to those who have not been trained in physics. They are here stated as simply as possible, and displayed with diagrams and illustrations.

The author is at pains to impress on the student and practitioners that radiotherapy can be used for many conditions besides malignant disease. This is emphasized in each succeeding chapter in the book; so much so that the practitioner may be unduly swayed by the enthusiasm of the author in forming his opinion and the advice he is going to give his patient. Many of the illustrations of inflammation and benign neoplasms show conditions that could have been better and more radically treated by properly planned surgical procedures, especially with the help of the modern plastic surgical technique, and with much less danger to the patient's well-being.

It is, however, in the treatment of cancer that radiotherapy has brought the greatest relief to mankind. The treatment of malignant disease is now agreed to be a surgical and radiotherapeutic problem with the biochemist and biophysicist looming up on the horizon.

The author agrees that in many cases surgery is the proper treatment, yet he leaves the impression on the reader that radiotherapy can always accomplish as much and more than surgery. Surgery attempts to remove every cancer cell from the body; its limitations are obvious: radiotherapy attempts to kill every malignant cell in situ; its limitations are bounded by its indiscriminate action on both abnormal and normal tissue. Neither can offer any certainty of a cure. The final answer may rest with chemotherapy.

The position was summed up by Lord Webb Johnson in his Bradshaw Lecture of 1940 on "Pride and Prejudice in the Treatment of Cancer" in these words: "When I embarked upon my inquiry I found an undercurrent of talk, wild misinformed criticism, a tendency to exaggerate failures, and over-statement of successes. Surgeons and radiotherapists were often in disagreement. There was indeed an atmosphere of 'pride and prejudice'."

That was the position ten years ago, but gradually there is emerging a more definite co-ordination in the methods of treatment of this fell disease. It must be a slow process, but that matters little if ultimately the rightful place of both surgery and radiotherapy in the treatment of cancer can be determined.

The grading of malignancy either clinically or histologically is most valuable in prognosis, but the latter, as always, depends most on early diagnosis. Whatever treatment is given the problem of metastasis remains, and until the factors controlling this can be determined and assessed no dramatic advance can be expected.

This book is a valuable contribution to the science and uses of radiotherapy. It shows what can be done by this treatment, but whether it is as certain by itself as when combined with properly planned surgery, is a matter to be determined by properly organized follow-up methods and properly analysed statistics over a great number of cases and a long period.

Modern Practice in Anæsthesia, 1949. Edited by FRANKIS T. EVANS, M.B., B.S., F.F.A.R.C.S., D.A., Honorary Anæsthetist, St. Bartholomew's Hospital, London. 6⅝ × 9⅝ in. Pp. 606 + xx, with 227 illustrations. 1949. London: Butterworth & Co. (Publishers) Ltd. 50s.

THE publication of this excellent book fulfills a definite need, for with the constantly increasing scope of modern anæsthesia it is becoming difficult for a single author to write with knowledge and authority on its many aspects. This volume contains thirty-eight chapters and these have been well written by twenty-four contributors who, as the editor remarks in his preface, "are men of standing and practical ability in their subject".

In regard to the choice of anæsthetic for the average routine operation there is no unanimity of opinion between the various authors, and it is evident that the virtues of cyclopropane are not so strongly advocated as they were a few years ago; on the other hand, the delinquencies of di-ethyl ether seemed to have declined and once again the merits of this ancient anæsthetic agent are recognized.

Readers will secure much valuable information from the chapter on local analgesia and abdominal field-block in combination with light anæsthesia, and we feel that surgeons would like to know of this veritable 'store-house' of clinical information in a subject which is of growing importance.

The art of condensing information concerning a large subject into a single chapter has always been a difficult achievement, and the authors of the chapters on "Blood Transfusion and Blood Replacement Therapy", "Anatomy for the Anæsthetist", and "Anæsthesia and Heart Disease", are to be commended on the excellence of their contributions.

Modern Practice in Anæsthesia is a valuable addition to the 'Modern Practice Series' and the editor and publishers are to be congratulated upon the excellent arrangement and production of this comprehensive and interesting volume, which should be read from cover to cover by every practising anæsthetist.

Varicose Veins. By R. ROWDEN FOOTE, London. $6\frac{5}{8} \times 9\frac{5}{8}$ in. Pp. 226 + xvi, with 181 illustrations and 3 coloured plates. 1949. London: Butterworth & Co. (Publishers) Ltd. 32s. 6d.

THIS book, which is dedicated to Lord Horder, is claimed by the author to be the first to be published in Great Britain solely on the subject of varicose veins.

He estimates that there are probably five million sufferers from the complaint in this country. On this account he thinks the prevention, treatment, and cure is a national problem. His opinion is justified, by the number of man-hours lost in industry from phlebitis and ulceration and the cost to the nation in dressings, drugs, and ointment. He claims, and rightly so, "that all sufferers can be benefited, that the majority of complications can be prevented, and that a high percentage of those who consult us can be cured".

He begins the book with a quotation from Sir Benjamin Brodie's lectures (1846): "This is a case in which there is no question of the patient's life or death and I think it probable that many of you may pass by the bedside of such a patient without thinking it worthy of attention".

He ends by another quotation from the same source: "Whosoever is sufficiently vain, or sufficiently idle, to rest contented at any period of his life, with his present acquirements, will soon be left behind by his more diligent competitors".

The book commences very properly with a historical survey of the landmarks in the treatment of varicose veins.

Hippocrates (460–375 B.C.) mentions the treatment he adopted. There are Grecian steles in existence figuring the condition. Instruments for the treatment were depicted in the surgical text-books of the seventeenth and eighteenth centuries and are shown in the text.

Sir Everard Horne (1756–1802) stated: "No surgical complaint, incident to the soldier, has deprived the Majesty's service of so many men as that of ulcers of the legs". (They may not all have been due to varicose veins!)

"The highest *surgical* admission rate (10 per cent) to the E.M.S. hospitals during World War II was for varicose veins", being second only to dermatological diseases. Of these 45 per cent were incapacitated for fourteen days and 11 per cent up to thirteen weeks. It will surprise some that injection of sclerosants has been practised since 1853, this method being instigated by the invention of the hypodermic syringe (1845–50). The combined method of operation and injection of sclerosants dates from 1908.

The author thinks that the erect posture is the main aetiological factor, as varices are not found in any quadruped. Heredity undoubtedly is a factor and *of course* a vitamin-deficiency must be invoked.

There is probably also an endocrine factor, as varices tend to appear at puberty and the menopause. In pregnancy also varicose veins may present before the pressure of its pelvic tumour can be a causative factor.

As always, the pathology present must indicate the treatment, so naturally the author goes into minute details as to the method of examination and application of special tests.

If the cause cannot be removed then the treatment is either conservative, sclerosant, or operative, or a combination of these.

The various methods of treatment are described in great detail and beautifully illustrated from actual cases occurring in his practice. This section of the book is invaluable to house surgeons, and even to those surgeons who have been graded as full consultants. The author definitely gives his method of treatment and states in no uncertain terms why he has reached this decision. He impresses on the reader that the saphenofemoral ligature must be a flush one with the femoral vein, and all the communicating veins at the upper end of the long saphenous must be ligatured.

For sclerosants he prefers 2 per cent phenol in 30 per cent glycerin, introduced into the distal portion by his own 'nutmeg grater' needle.

For local injections he prefers the 'empty vein' technique, and in all cases the patient should be as ambulatory as possible.

He gives full credit to those surgeons who, like himself, have now over a number of years been trying to impress surgeons with the importance of varicose veins and their correct treatment. To these, such as Dickson Wright, Maingot, Dodds, and others, it must often have seemed like a voice crying in the wilderness, but gradually it is being realized that varicose veins and their complications are not to be considered beneath the notice of the consultant and regulated to the care of the newly qualified house officer, whose surgical interests are usually those reflected from his chief.

Each hospital serving a large community should have a 'vein clinic' in charge of responsible surgeons.

This book, on the format and illustrations of which the author and publishers are to be congratulated, should be within reach of all house officers, even though they are wedded to the stethoscope and laboratory reports. They at any rate will see from the illustrations what can be achieved by proper careful treatment and that the cynical remark that the best method of dealing with varicose ulcer is to break the other leg is no longer true.

Plastic and Reconstructive Surgery. By EARL CALVIN PADGETT, M.D., F.A.C.S., Professor of Clinical Surgery, University of Kansas School of Medicine. With the collaboration of KATHRYN LYLE STEPHENSON, M.D., Instructor in Plastic Surgery, Tulane University of Louisiana, New Orleans. $11 \times 8\frac{1}{2}$ in. Pp. 945 + xxi, with 479 illustrations. 1948. Springfield, Ill.: Charles C. Thomas. (Oxford: Blackwell Scientific Publications Ltd.) £6 6s.

THIS monumental book must surely rank as an encyclopædia of plastic surgery as it is at present developed. Each page measures $11 \times 8\frac{1}{2}$ in. and the letterpress is in two columns. This is presumably to keep it in one volume, which has obvious advantages of convenient indexing. The type is such as to make it extremely easy to read, and the paper on which it is printed and

also the size of the page allows the figures in the text to be sufficiently large so that the reader can be quite certain as to what the author means when he gives details of the operations and methods he has found most satisfactory in his plastic and reconstructive work. He claims that a great deal of the surgery resulting from trauma should come, immediately after the injury, under the care of the reconstructive surgeon, and consequently in the book many procedures are discussed which in this country come within the province of the orthopædic, neurological, otolaryngological, thoracic, and even the general surgeon.

He claims that this is the first one-volume book to cover the field of " traumatic surgery of soft tissues, general reconstructive surgery, including certain grafting procedures in which cartilage or bone is indicated as the graft of choice, and plastic surgery along with cosmetic surgery ".

He points out the importance of his subject as this mechanized age has increased the need for reconstructive surgery. He also makes a plea that all undergraduate students should receive instructions in the fundamental principles of reconstructive procedures, as the end-result in the treatment depends as always on the correct and early diagnosis of the condition and underlying pathology so that proper treatment can be instituted as soon as possible.

Surely the ' fundamental principles ' are no different for reconstructive and plastic surgery than for ' general surgery ' ? In fact, as the successive chapters of the book are read, the main impression left is that it is only by a meticulous attention to detail of technique that the obvious success is due which the authors have evidently met with in their work. They agree with this when they state that the cardinal principles of successful reconstruction are asepsis, absence of tension, accuracy of co-aptation and obliteration of dead space, avoidance of leaving any raw surface, and atraumatic technique.

Provided that the undergraduate is taught to appreciate such fundamental principles, all the subspecialties of surgery can be safely left to the post-graduate period. There is admittedly a definite type of surgeon to whom plastic and reconstructive work makes special appeal, from its patiently time-consuming nature and the equanimity of mind which it demands.

The necessity for surgery, as the result of trauma, must be as old as mankind, and reconstruction of the part injured must have been attempted. Reconstructive surgery is mentioned in the Ebers Papyrus ; it was practised by the ancient Egyptians ; Galen and Celsus speak of reparative operations on the lips and cheeks. The arm flap method of rhinoplasty, as the authors state, was probably first practised about A.D. 1415 and revived, in preference to the forehead flap, by Tagliacozzi (1549–1599), Professor of Anatomy at Bologna, who illustrated it in his book published in 1597. An adaption of the original plate is used as the frontispiece for this book. That the operation supplied a long-felt need is stated by the authors, who on the authority of Addison and Steele (*Tatler*, No. 260, Dec. 7, 1710) say that at one time Tagliacozzi had under his care 12 German counts, 19 French marquises, and 100 Spanish cavaliers, but only 1 English squire.

The operation was condemned by ecclesiastics as it interfered with God's handiwork, and they were supported by Ambroïse Parè and Fallopius. The Faculty of Paris (1788) forbade face repairing, and so fervent was the opposition to it that ultimately the remains of Tagliacozzi were exhumed from their resting-place in a convent and re-interred in unconsecrated ground.

The Tagliacozzi method was satirized in Butler's *Hudibras* (1663) :—

> so learned Tagliocozzi from
> The brawing part of porter's bum
> cut supplemental noses . . .

Voltaire also made fun of the operation.

The feasibility and success of the operation of rhinoplasty was again admitted when agents from the British East India Company brought back reports of the success of the ' Hindoo ' operation, and the *Gentleman's Magazine* (1744) commented on and gave a description of a successful rhinoplasty.

All this and much more of the history of plastic surgery is given by the authors.

The indications for plastic and reparative surgery fall into four groups, viz., congenital defects, the result of trauma, and deformity as the result of new growth or infections.

The authors then proceed to consider these conditions seriatim. They commence with the fundamental principles, the materials used, and then the application of plastic surgery to each organ and tissue with the exception of gynæcology ; though it has been whispered elsewhere, that there are specialists who only practise ' gynopasty '.

The style of writing and illustrations are such that there is not a dull page in the book. At the end of each chapter there is a very complete list of references which the reader can consult for the originals. The index has been most carefully compiled and there is a very full appendix giving the method of preparation of the materials used by the authors in their work.

The last chapter on prosthesis and cineplastic amputations is of great interest to all surgeons, especially those interested in the results of trauma.

The book will long remain a vade-mecum for plastic surgeons and those training in this specialty. The whole book illustrates the quotation from Sir William Osler with which the authors commence it : " To study phenomena of disease without books is to sail an uncharted sea, while to study books without patients is not to go to sea at all ".

Diagnostic Radiology. For Practitioners and Students. By G. CLAESSEN, M.D., late Radiologist to the University Hospital, Reykjavik ; Lecturer to the University of Iceland, etc. With a Foreword by T. W. MCLAREN, M.A., M.R.C.S., L.R.C.P., D.M.R.E., Radiologist to St. Thomas's Hospital, London. English translation by the Author and ANNA LA COUR (*nee* Claessen). $6\frac{1}{8} \times 9\frac{3}{8}$ in. Pp. 411, with 396 illustrations. 1949. Copenhagen : Einar Munksgaard. (London : William Heinemann Medical Books Ltd.) 60s.

THIS book is written for practitioners and students, and gives a lucid description of the more common diseases and traumatic lesions in which radiology plays a part in the diagnosis of the condition. The book is well printed and is of handy size, and the illustrations, which are numerous, are well chosen and extremely well produced.

There can be no doubt that the student and practitioner will find this book a useful reference volume, but the former can hardly be expected to pay such a high price for such a book.

Surgery of Repair. Principles, Problems, Procedures. By JOHN F. PICK, S.B., M.M., M.D., F.I.C.S., Clinical Assistant Professor of Surgery, University of Illinois Medical School ; etc. In two volumes. 7 × 10 in. Pp. 828 + xii, with 1094 illustrations, including 17 colour plates. 1949. Philadelphia and London : J. B. Lippincott Co. £9 9s.

THE two large volumes which go to make up this work are devoted to the principles, problems, and procedures of plastic surgery. The author, who has had a vast experience in this branch of surgery, has given an over-all presentation of reparative surgery in the human body. The two world wars have given a great stimulus to

plastic surgery and to-day it forms a very definite branch of its own.

The principles of surgery are exactly the same in every branch, and that is why any surgeon who wishes to specialize in any particular branch should have a sound grounding in general surgery first.

The first volume deals with the surgery of trauma and the treatment of congenital defects. A very full description is given of the use of flaps and the closure of the wound. Post-operative management is discussed in detail and the removal of sutures is considered in a practical manner.

The various forms of skin-grafting are well described and illustrated and the different types of scar tissue are considered and appropriate treatment advised.

Volume II is devoted to a detailed description of the various forms of plastic operations on the abdomen, breast, cheek, ears, face, jaws, and lips.

These two large volumes give the reader a comprehensive account of plastic surgery as practised in America.

Anus : Rectum : Sigmoid Colon. Diagnosis and Treatment. By HARRY E. BACON, B.S., M.D., F.A.C.S., F.A.P.S., F.I.C.S., F.R.S.M., Professor and Head of Department of Proctology, Temple University Medical School and Hospital, Philadelphia ; Head of Department, St. Mary's Hospital ; etc. Third edition. 7 × 10 in. In two volumes. Pp. 1123 + xxv, with 755 illustrations. 1949. Philadelphia and London : J. B. Lippincott Co. £11.

WE are glad to see the third edition of this comprehensive work published in two volumes, and even so each volume is of large size. Both volumes are profusely and beautifully illustrated with photographs, radiographs, and photomicrographs. At the end of each chapter there is an up-to-date bibliography incorporating the most recent publications from both sides of the Atlantic.

Professor Bacon has a lucid style and has written a very readable work which is well printed. Perhaps he has given too much space to some operative procedures which are known to have limited value ; this is seen in particular in the treatment of procidentia.

One of the most useful chapters in the work is devoted to pre- and post-operative management of major surgical problems. The author's vast experience has stood him in good stead and that experience is evidenced in this chapter.

This third edition will still remain the best reference book on the subject and will be read by the student or post-graduate who wants to obtain a sound knowledge of diseases of the lower bowel and rectum.

Advances in Surgery. Chairman of Editorial Board : WILLIAM DE WITT ANDRUS, New York. Volume II. 6 × 9 in. Pp. 590 + xiv. Illustrated. 1949. New York and London : Interscience Publishers Ltd. 88s.

THE second volume of this work on advances in surgery contains some interesting articles. Sweet, of Boston, contributes a useful article on surgery of the œsophagus, and Smithwick deals comprehensively with the surgical treatment of hypertension. Allen Whipple writes on that new and fascinating subject, Portal Bed Block and Portal Hypertension, gives the surgeon some very practical suggestions for the treatment of this condition, and discusses the value of splenectomy and portocaval shunting procedures.

Other subjects dealt with are the treatment of cranio-cerebral injuries, the use of streptomycin in the treatment of surgical infections, the pathology of tumours of the peripheral nerves, and testicular tumours.

There is a very comprehensive list of references at the end of each section.

It is a pity that the paper on which this book is printed is not uniform in texture ; some articles are reproduced excellently while others on poor paper make reading difficult.

The modern surgeon will find a mass of information in this volume and it should prove a useful reference book.

Operative Surgery. By various authors. Edited by ALEXANDER MILES, M.D., LL.D., F.R.C.S. (Ed.), Consulting Surgeon, The Royal Infirmary, Edinburgh ; and Sir JAMES LEARMONTH, K.C.V.O., C.B.E., Ch.M., F.R.C.S. (Ed.), Regius Professor of Clinical Surgery and Professor of Surgery, University of Edinburgh. Third edition. 5⅜ × 8½ in. Pp. 559 + x, with 235 illustrations. 1950. London : Oxford University Press. 30s.

IT is some fourteen years since the last edition of this work appeared, and during that time much has happened in the sphere of operative surgery.

The present volume, in which the name of Sir James Learmonth appears for the first time, has been very completely revised and much new matter has been added. It truly represents the present-day practice of the Edinburgh School of Surgery. The new illustrations are numerous and on the whole are very good, the majority come from the pen and brush of Mr. Clifford Shepley, but a few, such as the figures illustrating the operations on herniæ, are not up to standard ; the transversalis fascia depicted in Fig. 207 appears thicker than the aponeurosis of the external oblique ; the spermatic cord appears as a well-marked tube! However, these are small defects in what is really an excellent volume.

The editors have been fortunate in their selection of the various authors who have contributed to this book, for they certainly have written excellent chapters dealing with their specialities. The one branch of surgery which is not included in this volume is neurosurgery, the editors' excuse being that the general surgeon is not required to do operations on the brain and central nervous system. If this is so, is a general surgeon required to do lobectomies, total laryngectomies, and radical mastoid operations ? These operations are described in detail.

Injuries of the Brain and Spinal Cord and their Coverings. Neuro-psychiatric, Surgical, and Medico-legal Aspects. Edited by SAMUEL BROCK, New York University. Third edition. 6 × 9 in. Pp. 783 + xii, with 125 illustrations. 1949. London : Baillière, Tindall & Cox. 76s. 6d.

THE third edition of this book is the result of a good deal of revision on the part of its twenty-eight contributors. It contains a new section by Dr. Francis A. Echlin on herniation and protrusion of intervertebral disk tissue. There are also completely new chapters on injuries of the vertebral column and spinal cord, on the neuroses following head injuries, and on the effects of electric shock on the nervous system. There are also a few changes in the contributors, who now number 28 as compared with 23 in the second edition.

The book contains a wealth of information on the many aspects of the subject of injuries of the central nervous system and for the most part fulfils its editor's object of describing in detail the immediate and remote effects of such injuries of the brain and spinal cord. It is less detailed in the treatment of some aspects of the subject than of others ; thus blast injury of the brain is dismissed in a couple of brief paragraphs and we looked in vain for a balanced discussion on depletion therapy in cerebral contusion and on delayed paraplegia in spinal injuries. While the two original British authors remain,

references throughout are almost all American and the work of many British authors goes unnoticed; Grey Walter's name is conspicuously absent from those in the bibliography on electro-encephalography, and Murray Falconer's and Harvey Jackson's from the section on intervertebral disks. Proof-reading has for the most part been well done, but Lasèque (p. 603) should be Lasègue and an occasional text reference is missing from the bibliography at the end of the chapter in which it appears, e.g., Andrae (1929), p. 584. Nevertheless, this book remains a valuable, if essentially American, contribution to the various questions of traumatic lesions of the brain and cord, and the present volume can be as warmly recommended as the previous edition.

Accessory Bones of the Human Foot. A Radiological, Histo-embryological, Comparative-Anatomical, and Genetic Study. By DYRE TROLLE, Copenhagen. Translated from the Danish by ELISABETH AAGESEN, Copenhagen. $6\frac{1}{4} \times 9\frac{1}{4}$ in. Pp. 272, with 127 illustrations. 1948. Copenhagen: Einer Munksgaard. Dan. kr. 22.

THE author has made an exhaustive study of the occurrence of accessory bones of the human foot by the X-ray examination of a large number of feet. In an endeavour to elucidate the genesis of these accessory bones he has sectioned 508 paired feet from 254 embryos and has also referred to the anatomy of the foot of other vertebrates. As a result of this work he described 35 accessory bones which can be explained: (*a*) An independent cartilaginous primordium of phylogenetic, neogenetic, or anomalous origin; (*b*) An inconstant centre of ossification; (*c*) A tendon bone, i.e., a postnatal formation developed on account of local irritants acting from without; (*d*) A non-recognized pathological lesion or minor fracture.

Whilst this monograph will be of interest mainly to anatomists, its comprehensive nature and complete bibliography make it a valuable reference book for the orthopædic surgeon and radiologist.

La Chirurgie de la Douleur. By RENÉ LERICHE, Professeur au Collége de France. Third edition. $6\frac{3}{8} \times 9\frac{5}{8}$ in. Pp. 471 + viii. 1949. Paris: Masson et Cie. 1450 fr.

La Chirurgie de la Douleur was first published in 1937 and a translation by Professor Archibald Young was reviewed in this JOURNAL in 1939. The original work was based on twenty lectures delivered by Professor René Leriche at the College of France. His aim was primarily to enlarge on the pathology and physiology of the subject. His book exhibited an originality of outlook and attractiveness of style which compelled attention and stimulated thought. In the introduction to the third edition the author states that he realized the difficulty of revising his first essay on a subject he had so much at heart and that he has therefore largely rewritten it. Though thereby there are considerable additions to the subject-matter, he decided not to include consideration of the surgical problems of the prolapsed disk (' discopathies ').

Professor Leriche repeats his conviction: " Je pense toujours que la douleur n'est ni sur le plan de la vie, ni dans l'ordre physiologique." He is in general critical of the approach to the problem by the average neurosurgeon, and of them he expresses the view: " Leur tendance a ne s'addresser qu'aux voies sensitives pour les interrompre en négligeant les méchanismes de la mise en jeu de la douleur est, a mon avis, en retard . . ." That this personal view is a relative one may be noted by the fact that while he does not approve of cordotomy for any painful state he remains a firm upholder of neurotomy in the treatment of trigeminal neuralgia. Cordotomy he abandoned in 1927 after giving it an extensive trial. After neurotomy for neuralgia he has observed but one failure in 250 cases with which he has been connected.

His presentation of case-histories and results is individual in character. He lays little store by statistics and does not overburden his text with details of surgical technique. Although an ardent exponent of periarterial and nodal sympathectomy, he has swung further to the conviction that in many instances an endocrine disturbance is at the root of the trouble. His report of thymectomy which gave complete relief from the severe pain of a chronic arthritis may be quoted as an example supporting this view. Trials are recorded of many different procedures in almost every part of the body for the relief of pain of various origins. There is an atmosphere of sound clinical sense about most of his comments, and the author demonstrates his breadth of view by the fullness with which he notes and assesses the results of other workers in the same field.

It would be difficult and indeed presumptuous to outline and criticize in the compass of this review all the ideas of the gifted author. Essays on surgical subjects seldom infuse a sense of excitement in the reader. This book is an exception, and however much the author's attractive style of presentation may help to such an influence, it originates in his ability to convince one of the importance of the subject and from his power to inspire the reader with the belief that his methods may yield some outstanding advance.

The Middlesex Hospital. By HILARY ST. GEORGE SAUNDERS. $6\frac{1}{4} \times 8\frac{3}{4}$ in. Pp. 100, with 4 coloured plates and 29 illustrations. 1950. London: Max Parrish & Co. Ltd. 8s. 6d.

" *Non ignara mali, miseris succurrere disco* " (knowing something of misfortune myself I am learning to succour the distressed).

What better motto could be adopted by a great voluntary hospital and medical school? It sums up the ideals of such an institution and as one reads the book, it is realized what an important part has been played by the Middlesex in the development of medicine and surgery, especially in the last hundred years.

The hospital is also fortunate in having secured as the author of this book Mr. Hilary St. George Saunders, the librarian of the House of Commons.

The book in its way is as thrilling as the illustrated war documentaries he wrote for the Air Ministry, viz., " The Battle of Britain ", " Bomber Command ", and " Coastal Command ". The terseness and penetration of its style and language is a joy to read.

Some years ago a series of articles on the history of the great voluntary hospitals of the country were published from time to time by the *Medical Press and Circular*, and it would supply a long-felt want if they were republished in book form. It seems a pity that the history of the inception and development of these institutions should be lost to the lay and medical community now that they have all been swallowed by a scheme of medical nationalization.

Those who founded them and gave so freely of their means for their improvement and development, were usually of the ' privileged classes ', but they realized their responsibilities to the less fortunate. These hospitals were, however, far from being dependent merely on gifts and legacies from the rich. The voluntary hospitals seem to have been the last of the great charities to organize a national appeal for themselves. It was Canon Miller, of Birmingham, who in 1850 arranged for a simultaneous appeal through the churches once a year, on what has been known since as ' Hospital Sunday '. This fund is still in being.

In 1851 the ' Hospital Saturday Fund ' was founded. The latter was referred to as the ' Working Man's Fund ', the former as the ' Churchman's Fund '. " The King Edward Hospital Fund for London " was started by King Edward VII, then Prince of Wales, in 1897, in commemoration of Queen Victoria's Diamond Jubilee.

Then early in this century special contributory schemes were started amongst the community which the hospital served. As the cost of the necessities for medical progress and treatment rose higher and higher most of the voluntary hospitals would have had to go into liquidation, had they not been financed and saved by these ' Workmen's Contributory Schemes '. The employers usually added a third of the amount collected from the workmen. It was at first 1d. in the £1 of wages and later increased to 1½d. In one community this fund provided £350,000 a year for the local hospitals.

The hospitals were nationalized on the appointed day, July 5, 1948, and though every endeavour has been made to maintain voluntary help for the needy, it is bound to become a diminishing amount in this materialistic age.

Of all the Christian traditions which have persisted down through the ages, none has been more characteristic than that of charity in its broadest sense (i.e., love), which means a sincere desire for the well-being of others and a readiness to help those in need.

The comprehensive social planning of the modern welfare state may have produced in some people the feeling that responsibility towards their fellow men has been in large measure removed. It is well to remember—

> In faith and hope the world will disagree,
> But all mankind's concern is charity.

There were no voluntary hospitals in London before 1719. St. Bartholomew's and St. Thomas's, which were re-established by Henry VIII, were Royal Hospitals, the distinction, according to Dr. Peachey, being that the Royal Hospitals were chartered and endowed with the rents and possessions of religious houses. The voluntary hospitals had no charter, were not endowed, and were wholly dependent on the subscriptions and endowments of the public. The administration of the Royal Hospitals was in the hands of the Lord Mayor and Aldermen of the City of London; that of the voluntary hospital was in the hands of the subscribers. The Medical Officers of the Royal Hospitals were paid for their services and had no voice in the management. Those of the voluntary hospitals were honorary and received no salary, but as Governors they enjoyed the right of voting on all matters. At the Royal Hospitals fees were demanded from all applicants for admission and the Lord Mayor had the right to levy a rate upon the citizens on behalf of the Royal Hospitals. The voluntary hospitals demanded a recommendation for the patient from a subscriber but no fees were asked for. This is probably the origin of the name ' Royal Free Hospital '.

In the middle decades of the eighteenth century several voluntary hospitals were opened in London, only one of which, viz., Guy's (1725) has the name of the founder as its title.

The Middlesex was opened in 1745, the year of the Jacobite rebellion and the year in which the old Company of Barber Surgeons was dissolved, and the Surgeons finally separated from the Barbers. From the time of its opening until ' the Day ' (July 5, 1948) when it was taken over by the Government, its record is one of continual progress in its development and influence, not merely to meet " the needs of the sick and lame of Soho ", but to meet and relieve the ills of all who sought succour at its doors.

It has also played a most important part in the development of medical education since its medical school was founded in 1836, mainly by the efforts of Sir Charles Bell. The foundation of this school was really due to the determination of the Governors and staff to preserve their freedom and their refusal to have interference by the authorities of the University of London, who as a preliminary had paid the hospital staff the compliment of appointing one of its members, Sir Thomas Watson, as Professor of Medicine, and another, Sir Charles Bell, as Professor of Surgery at the University.

There have been no less than six Presidents of the Royal College of Physicians who have been members of the staff of the Middlesex Hospital. This office was occupied continuously for forty years from 1804 to 1844 by them, one of whom, Sir Henry Halford (Henry Vaughan) was President from 1820 to 1844.

They have not supplied as many Presidents of the Royal College of Surgeons, but what has been lacking in quantity has been compensated by the quality of those selected.

No less than five masters of the Surgeons' Company between 1745 and 1800 were also surgeons to the Middlesex Hospital. There were only two Presidents of the Royal College of Surgeons from the Middlesex Hospital during the period 1800 to 1900. In 1906–1908 the President of each Royal College was on the staff of the Middlesex. These details show the esteem and regard in which the staff of this hospital was held by their professional colleagues. In the present century there have been three members of the Middlesex staff elected as Presidents of the Royal College of Surgeons, two of whom, viz., Sir John Bland-Sutton and Lord Webb-Johnson, will go down to history for the part they have played in the rebuilding and re-organization both of the Middlesex Hospital and The Royal College of Surgeons of England.

It is perhaps with the problems of medical research, especially with regard to cancer, that the name of the Middlesex Hospital will always be linked.

In 1791 the ' Cancer Charity ' of the Middlesex Hospital was organized as the result of an anonymous gift from Mr. Samuel Whitbread. A rule was made as follows: " The Governors have rendered the cancer establishment for the trial of every new method of treatment which can with safety and propriety be adopted " . . . the condition being, " Those who proposed them should previously satisfy the medical staff of their safety and within a reasonable time consent to make the treatment public ".

The condition proved too much for the ' cancer curers ' of those days. The further development of cancer research at the Middlesex can be summed up as follows: The epoch-making publications of Charles H. Moore, one of the surgeons, viz., in 1865, " On the Antecedents of Cancer ", thereby recognizing pre-cancerous conditions; in 1867 " The Influence of Inadequate Operations on the Theory of Cancer ". Thomas Nunn's " Cancer of the Breast " (1882) and his book on *Cancer*, published in 1899. In 1893 Bland-Sutton wrote the book which has become a classic on *Tumours Innocent and Malignant*. In 1903 Sir Henry Morris gave a Bradshaw Lecture at the Royal College of Surgeons on " Cancer and Its Origin ". In 1899 the Cancer Research Laboratories were opened at the Middlesex and later extended, and wards added by the munificence of Mr. Barnato Joel. It was the first voluntary hospital to use radiotherapy. This began with the implantation of radium in 1909 by Sir Alfred Pearce Gould, and has developed into a great radiotherapy department under the direction of Professor M. W. Windeyer, treating " an average of 600 patients a month ".

It was the first hospital to appoint a bio-physicist, Professor Russ, in the Department of Radiotherapy. After World War I the M.R.C. lent the Middlesex Hospital a quantity of radium, and with it Professor Russ developed the first radium unit. He became the first secretary of the National Radium Commission.

In 1928 the Institute of Biochemistry was inaugurated and endowed by the generosity of Mr. Courtauld, in which, under the direction of Professor Dodds, have been made the epoch-making discoveries of the influence of hormones on cancer in certain tissues.

The position in the surgical treatment of cancer based on an appreciation of its pathology has been summed up by the publications of Sampson Handley, sen., and the relationship of radiotherapy to surgery in the treatment of cancer in general, by Lord Webb-Johnson in the Bradshaw Lecture of 1940 (" Pride and Prejudice in the Treatment of Cancer ").

It has not been merely in the treatment and investigation of cancer that the Middlesex has played such an important part. It has had in the past a succession of surgeons whose science and art has been based on anatomy, the outstanding ones this century being Sir Henry Morris, Sir Gordon Gordon-Taylor, Comyns Berkeley, and Victor Bonney. The traditions they founded are being developed by their successors, who are maintaining the position of the hospital with regard to the newer surgery or surgery of function.

The professors of the preclinical subjects are also pre-eminent in their specialty. At the same time the various ' hospital ' schools have been developed and their influence extended, such as the school of nursing, school of radiology, radiotherapy, physiotherapy, etc. " There is much else besides . . . if all of it were put in writing, I do not think the world itself would contain the books which would have to be written ".

As has been already said, it is a good thing that the history of our great voluntary hospitals should be told, before those who know it are no more. This book will be a joy to all old ' Middlesex ' men and nurses. It will conjure up many enjoyable memories. To the present generation it will give them the traditional background of their hospital.

If the motto of the hospital conveys the art of medicine and surgery as practised at the Middlesex, then the science is summed up by that of the British Empire Cancer Campaign : " *quod refert quis opus faciat modo denique fiat* " (What does it matter who does the work so long as the work is done ?).

British Surgical Practice. General Editors : Sir ERNEST ROCK CARLING, F.R.C.S., F.R.C.P., Consulting Surgeon, Westminster Hospital ; and Sir JAMES PATERSON ROSS, K.C.V.O., M.S., F.R.C.S., Surgeon and Director of Surgical Clinical Unit, St. Bartholomew's Hospital ; Professor of Surgery, University of London. In eight volumes. $6\frac{3}{8} \times 8\frac{3}{8}$ in. Volume VII. Pp. 591 + xxvi, with 339 illustrations. 1950. London : Butterworth & Co. Ltd. Price per volume £3, Index £1.

THE seventh volume of this work contains some excellent articles by well-known surgeons. Morley deals with the subject of pharyngeal diverticula, and for treatment advocates a transverse collar incision at the level of the cricoid cartilage, as he considers that this exposure gives good access and a better cosmetic result. Riches writes in an interesting and comprehensive manner on the prostate, and his matured clinical experience is clearly evident in this chapter. Twistington Higgins gives the reader a very practical discourse on the treatment of pyloric stenosis of infants, his remarks being illustrated with some very fine clinical photographs. Sir Harold Gillies and Patrick Clarkson deal with the reconstruction of the ear and nose in a most able manner, making the various operations appear simple. Lambert Rogers writes on the surgery of the spinal cord in a very readable and practical way.

This volume is in keeping, in its usefulness, with the previous parts of this work and is an indication of the virile and progressive state of British Surgery. The volumes of this work will remain the reference books in modern surgery both at home and abroad for many years to come.

A Textbook of Surgery. By American authors. Edited by FREDERICK CHRISTOPHER, B.S., M.D., F.A.C.S., Professor of Surgery, Northwestern University Medical School ; Chief Surgeon, Evanston (Illinois) Hospital. Fifth edition. $6\frac{7}{8} \times 10$ in. Pp. 1550 + xxv, with 742 illustrations. 1949. Philadelphia and London : W. B. Saunders Co. 65s.

THE new fifth edition of this comprehensive text-book of surgery has been very thoroughly revised and much new matter has been incorporated. The whole large volume is divided into innumerable sections, all of which are written by well-known American surgeons. The sections dealing with acidosis and alkalosis and with water and electrolyte balance are particularly good.

New sections in this edition include tumours of the tendons and tendon-sheaths ; birth fractures and dislocations ; pyogenic infections of the skin ; dan pre- and post-operative care.

The illustrations, which number 1465, are on the whole good, but some seem to have become faded owing to the large number of pulls that have been made.

There are some misleading statements, such as the following on page 731 : " Basal-cell epitheliomas may be treated successfully in the great majority of cases by radiotherapy which is probably the method of choice. Twenty per cent of the neoplasms diagnosed clinically as basal-cell epitheliomas prove on microscopic section to be basal-squamous cell epitheliomas. They should be excised widely and deeply, because both are relatively resistant to radiotherapy." Passages such as this leave the reader in a complete muddle as to what is the best treatment in cases of rodent ulcers.

However, taken as a whole this text-book will serve the student well and will enable him to pass his examination in surgery.

When the next edition is produced we hope that the publishers will consider the possibility of two volumes because the present book is large, bulky, and heavy.

Treatment in Proctology. By ROBERT TURELL, B.S., M.D., New York. With a Chapter on Psychosomatic Problems by LOUIS LINN, M.D. 6 × 9 in. Pp. 248 + xiv, with 85 illustrations and 9 coloured plates. 1949. London : Baillière, Tindall & Cox. 54s.

THE author of this new book is well known for his writings on proctological subjects, particularly the removal of rectal and rectosigmoidal polyps by endoscopic procedures, and the treatment of intractable pruritus ani by tattooing with mercury sulphide. These are among the subjects described and very fully illustrated. The opening chapters give a useful account of sulphonamide and antibiotic therapy up to and including the streptomycin era.

Some interesting suggestions are given for the local use of hæmostatic agents in rectal surgery, such as gelatin sponge and oxydized cotton ; gelatin sponge soaked in penicillin solution (50,000 units per c.c. of water) is recommended for packing abscess cavities. A fair and up-to-date consideration is given of various surgical procedures—for instance, for malignant lesions, pilonidal sinus, hæmorrhoids, prolapse, and wounds of the rectum. Long and informative chapters are presented on diarrhœa and dietetics ; useful diet tables, such as those for low-roughage, low-residue, high-protein, and high-vitamin diets, are given, as well as a low-protein diet with lactose and acidophilus milk suitable for some cases of anal pruritus. A chapter on psychosomatic problems in proctology is given by Dr. Louis Linn, and

there is also a useful summary of drugs in common or occasionaly use in rectal and colon cases, with dosages.

We consider this to be a very good and timely addition to proctological literature. Within its 250 pages a great amount of up-to-date information and discussion of current practice is given in an attractive manner. The illustrations, especially the radiographs and photomicrographs, are uniformly excellent, and great care has obviously been taken in choosing the bibliographies at the ends of chapters or sections of chapters. The author and publishers are to be congratulated on this production. The Foreword is by Dr. Curtice Rosser.

Surgical Management of Vascular Diseases. By GERALD H. PRATT, M.D., F.A.C.S., Associate Clinical Professor of Surgery, New York University; etc. 6 × 9⅛ in. Pp. 496, with 181 illustrations. 1949. London: Henry Kimpton. 70s.

DURING the last decade more progress has been made in the treatment of vascular diseases than in any previous period. The time is ripe therefore for an up-to-date text-book on this subject and Professor Pratt has produced it. The surgery of the heart and big vessels has been made possible by the great advances in the surgery of the thorax, modern anæsthesia, blood transfusion, and the extensive use of chemotherapy and anticoagulants.

It is interesting to note that the author stresses the importance of the case history of the patient; this is so often neglected to-day.

A large section of the book is devoted to occlusive arterial disease and the many and varied forms of treatment for this condition are well described; varicose veins, arterial varices, and hæmangiomata are considered in detail and their treatment is set out in a very practical way.

The surgery of the heart occupies a large section of the book, and the treatment of congenital vascular defects of children, such as coarctation of the aorta and patent ductus arteriosus is described and illustrated. The use of angiography is stressed and the value of cardiovascular catheterization is discussed. At the end of each chapter a bibliography of modern papers on the subject under review is given, but there is a paucity of British references.

The book covers the subject of vascular diseases adequately and the illustrations are on the whole good. It will take its place as the reference book on the surgical management of vascular diseases for some time to come.

Pye's Surgical Handicraft. Edited by HAMILTON BAILEY, F.R.C.S., F.A.C.S., F.I.C.S., F.R.S.E. Sixteenth edition. 5½ × 8½ in. Pp. 724 + xii, with 830 illustrations, many in colour. 1950. Bristol: John Wright & Sons Ltd. 25s.

THE new sixteenth edition of *Pye's Surgical Handicraft* is full of practical instruction which will prove of real value to resident medical officers. During the sixty-six years in which this book has been in use many thousands of surgeons have been grateful to 'Pye' for the practical instruction contained within its pages. In this new edition there are several new contributors, two of whom are from America, namely, John Holt, who deals with the surgery of the nose and accessory sinuses, and Ralph Lloyd, who writes on emergency dental treatment.

The new edition certainly upholds the reputation of its predecessors and is a valuable book for all house surgeons and practitioners.

Operations of General Surgery. By THOMAS G. ORR, M.D., Professor of Surgery, University of Kansas School of Medicine. Second edition. 7¼ × 10¼ in. Pp. 890 + x, with 721 illustrations. 1949. Philadelphia and London: W. B. Saunders Co. 67s. 6d.

THE new second edition of this large volume on operative technique has many new illustrations, all of which are good and enhance the value of the book. Since the first edition appeared in 1944 there has been considerable advance in many branches of surgery. The outstanding advance has been made in vascular surgery and Professor Orr has incorporated the work of Blalock and others on the surgical treatment of anomalies of the aortic arch.

New technique for œsophagogastrostomy, total gastrostomy, total gastrectomy, pancreaticoduodenectomy, stricture of the bile-ducts, excision of the colon, and prolapse of the rectum have been described and illustrated.

The use of silver wire in the closure of abdominal incisions is well described and given its proper place. The various forms of herniæ are discussed and the detail of the operations for their cure is given in a very lucid way.

We are surprised to find no mention of Edmund's operation for the cure of hypospadias, as it gives better results than any other operation so far described.

That a drain is not necessary after the excision of a pilonidal cyst or sinus is rather surprising, and, if taken to heart, will cause a spate of hæmatomata in the wounds of patients following operation for this condition.

This book will continue to prove of value to the younger group of surgeons who are starting on their career.

Congenital Malformations of the Heart. By HELEN B. TAUSSIG. New York: The Commonwealth Fund. $10.00.

THIS book, the work of a 'master' in the subject and a great pioneer in the surgical relief of the cyanotic group of congenital malformations, is indispensable to the serious worker in this field and should be consulted by all who wish to become familiar with the problems involved. It can be used either as a text-book or as a book of reference. It is profusely illustrated with good diagrams, good radiographs, and many coloured charts to show the vagaries of the circulation in congenital malformations of the heart. A noteworthy feature is the excellent exposition of the radiographic study of these cases. Since the book was written great strides have been made with angiocardiography and cardiac catheterization, and no doubt when the inevitable new edition appears it will contain a full account and assessment of these important methods of investigation in relation to cases of congenital heart disease. This is a monumental work which will inevitably become a classic.

BOOK NOTICES

[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest to the readers.]

Die chemotherapeutische Tamponade der Lungenkavernen. By GUSTAV MAURER, Davos. $6\frac{5}{8} \times 9\frac{3}{8}$ in. Pp. 114, with 51 illustrations. 1950. Stuttgart: Georg Thieme. DM. 18.

Pyramidensiterungen deren Verhutung und Behandlung. By Professor Dr. O. VOSS, Frankfurt a.M.-Berchtesgaden. $6\frac{5}{8} \times 9\frac{3}{8}$ in. Pp. 256, with 71 illustrations. 1949. Stuttgart: Georg Thieme. DM. 36.

Skin Grafting. By JAMES BARRETT BROWN, M.D., Professor of Clinical Surgery, Washington University School of Medicine; etc.; and FRANK MCDOWELL, M.D., Assistant Professor of Clinical Surgery, Washington University School of Medicine, St. Louis, Missouri. Second edition. 7 × 10 in. Pp. 339 + x, with 239 illustrations. 1949. Philadelphia and London: J. B. Lippincott Co. 60s.

Atlas of Amputations. By DONALD B. SLOCUM, M.D., M.S. $8\frac{1}{2} \times 11$ in. Pp. 562, with 564 illustrations. 1949. London: Henry Kimpton. £7.

William Withering of Birmingham. By T. WHITMORE PECK, M.P.S., and K. DOUGLAS WILKINSON, O.B.E., M.D. (Birm.), F.R.C.P. (Lond.). $5\frac{1}{2} \times 8\frac{3}{4}$ in. Pp. 239 + viii, with Frontispiece and 53 plates. 1950. Bristol: John Wright & Sons Ltd. 21s.

L'Organisation des Os. By P. LACROIX, Professeur à la Faculté de Médecine de Louvain. $6\frac{1}{8} \times 9\frac{1}{2}$ in. Pp. 230, with 87 illustrations. 1950. Paris: Masson et Cie. 900 fr.

Intestinal Intubation. By MEYER O. CANTOR, M.S., M.D., F.A.C.S., Assistant Attending Surgeon, Grace Hospital, Detroit, Mich. $5\frac{7}{8} \times 8\frac{7}{8}$ in. Pp. 333 + xiv, with 147 illustrations. 1949. Springfield, Ill.: Charles C. Thomas (Oxford: Blackwell Scientific Publications Ltd.). 55s.

Les Tumeurs malignes des Voies aéro-digestives supérieures. By J. DUCUING, Professeur de Clinique chirurgicale et du Cancer; Directeur du Centre anti-cancéreux de Toulouse; and L. DUCUING, Ancien Laryngologiste du Centre anti-cancéreux de Toulouse. $6\frac{1}{8} \times 9\frac{1}{2}$ in. Pp. 582 + viii, with 170 illustrations. 1950. Paris: Masson et Cie. 2000 fr.

Fractures. By PAUL B. MAGNUSON, M.D., F.A.C.S., Professor of Bone and Joint Surgery and Chairman of the Department, Northwestern University Medical School, Chicago; etc.; and JAMES K. STACK, A.B., M.D., F.A.C.S., Assistant Professor of Bone and Joint Surgery, Northwestern University Medical School, Chicago; etc. Fifth edition. 6 × 9 in. Pp. 537 + xx, with 325 illustrations. 1949. Philadelphia and London: J. B. Lippincott Co. 55s.

Emergency Surgery. By HAMILTON BAILEY, F.R.C.S. (Eng.), assisted by NORMAN M. MATHESON, M.R.C.P., F.R.C.S. Sixth edition. Part III. Pp. 168 + iv, with 247 illustrations, many coloured. 1950. Bristol: John Wright & Sons Ltd. Per part 21s.

Surgery for Nurses. By JAMES MORONEY, M.B., Ch.B., F.R.C.S. (Eng.), L.R.C.P. (Lond.), Visiting Consulting Surgeon, Clatterbridge General Hospital, Cheshire, and Broadgreen Hospital, Liverpool; Examiner in Surgery to the General Nursing Council for England and Wales. With a Foreword by DOROTHY M. SMITH, O.B.E., Chairman of the General Nursing Council for England and Wales; Matron, Guy's Hospital, London. $5\frac{1}{2} \times 8\frac{1}{2}$ in. Pp. 644 + xii, with 563 illustrations, a number in colour. 1950. Edinburgh: E. & S. Livingstone Ltd. 27s. 6d.

Lehrbuch der röntgenologischen Differentialdiagnostik. By WERNER TESCHENDORF, Cologne. Second edition. In two volumes. $6\frac{7}{8} \times 10\frac{1}{8}$ in. Vol. I: Erkrankungen der Brustorgane. Pp. 780 + xii, with 865 illustrations; Vol. II: Erkrankungen der Bauchorgane. Pp. 608 + viii, with 1081 illustrations. 1950. Stuttgart: Georg Thieme. Vol. I, DM. 84; Vol. II, DM. 72.

The 1949 Year Book of General Surgery (August 1948–July 1949). Edited by EVARTS A. GRAHAM, A.B., M.D., Professor of Surgery, Washington University School of Medicine; etc. $4\frac{5}{8} \times 7$ in. Pp. 707, with 216 illustrations. 1949. Chicago: Year Book Publishers Inc. (London: H. K. Lewis & Co. Ltd.). 37s. 6d.

The 1949 Year Book of Urology. Edited by OSWALD S. LOWSLEY, M.D., F.A.C.S., New York. $4\frac{3}{4} \times 7$ in. Pp. 445, with 62 illustrations. 1950. Chicago: The Year Book Publishers Inc. $5.00.

Neoplasms of Bone and Related Conditions. Their Etiology, Pathogenesis, Diagnosis, and Treatment. By BRADLEY L. COLEY, M.D., Attending Surgeon, Bone Tumor Department, Memorial Hospital for Cancer and Allied Diseases; Assistant Professor of Clinical Surgery, Cornell. 7 × 10 in. Pp. 765 + xiv, with 389 illustrations. 1950. New York: Paul B. Hoeber Inc. (London: Cassell & Co. Ltd.) £6 10s.

Chirurgie artérielle. Techniques, Indications, Résultats. By G. ARNULF, Nancy. With a Foreword by Professor RENÉ LERICHE. $6\frac{1}{2} \times 9\frac{3}{4}$ in. Pp. 248 + viii, with 79 illustrations. 1950. Paris: Masson et Cie. 1200 fr.

The Principles and Practices of Rehabilitation. By HENRY H. KESSLER, M.D., Ph.D., in collaboration with other authors. $5\frac{7}{8} \times 9\frac{1}{8}$ in. Pp. 448, with 132 illustrations. 1950. London: Henry Kimpton. 63s.

Lehrbuch der Röntgendiagnostik. By H. R. SCHINZ, W. E. BAENSCH, E. FRIEDL, E. UCHLINGER, with the assistance of several contributors. Fifth edition. $7\frac{1}{2} \times 11$ in. To be published in 3 volumes. Volume I (The Skeleton), Part 1. Pp. 426 + viii, with 507 illustrations, and 58 plates. 1950. Stuttgart: Georg Thieme. DM. 66.

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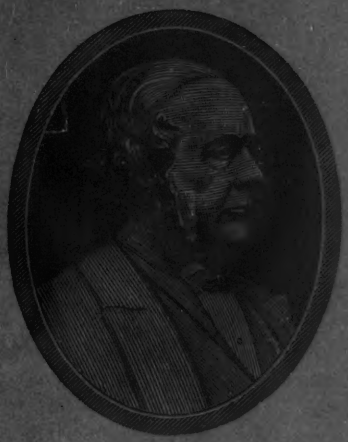

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